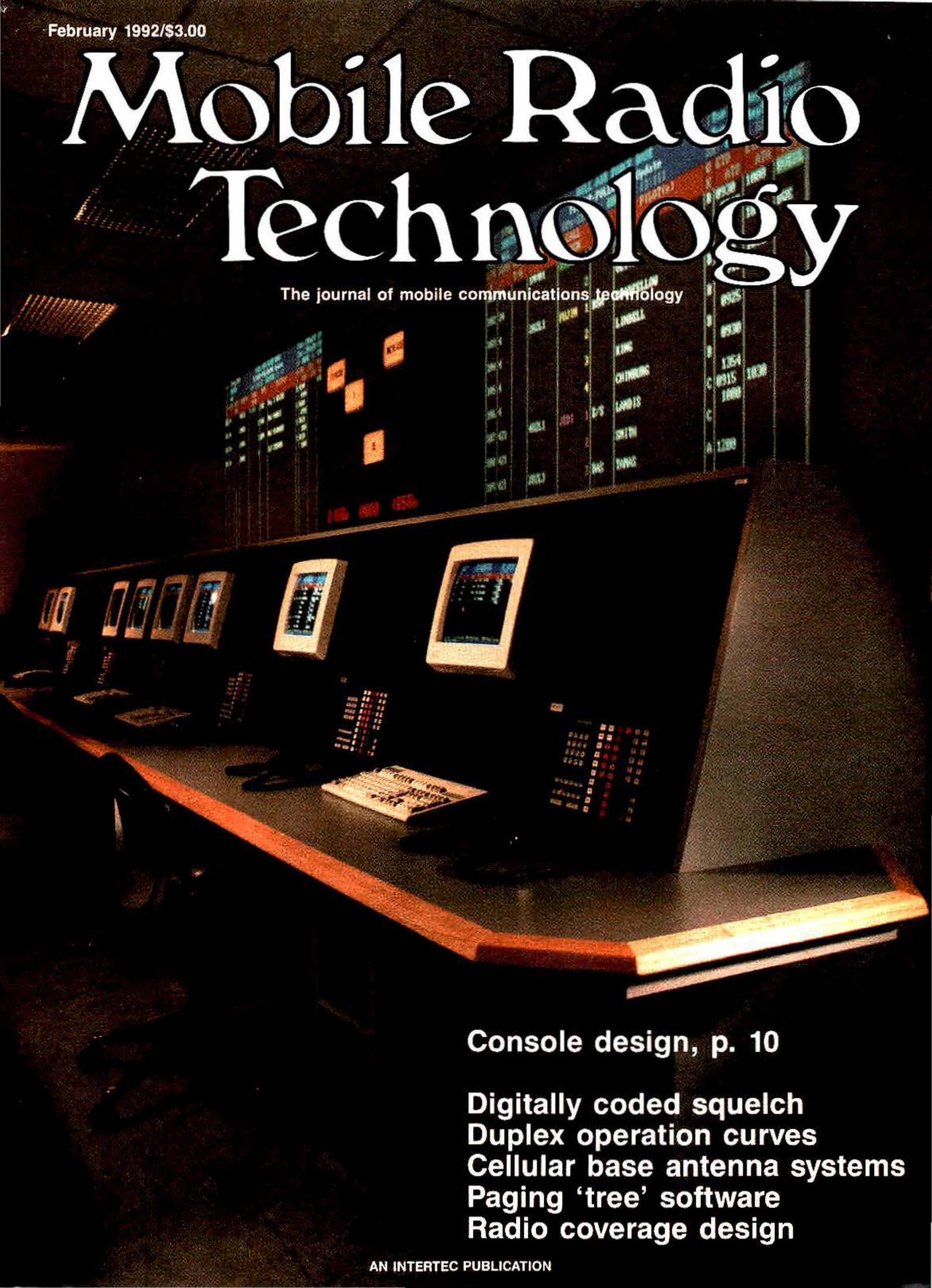
February 1992/$3.00

Mobile Radio Technology

The journal of mobile communications technology

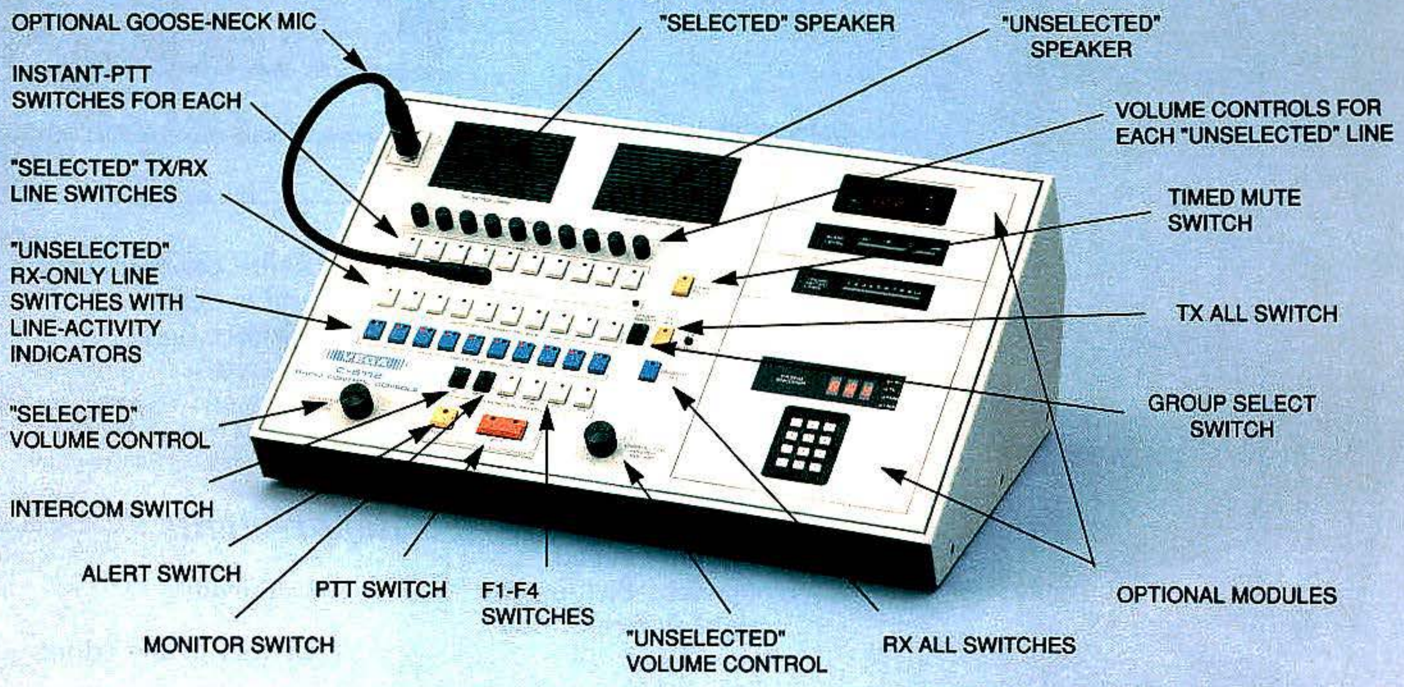


Console design, p. 10

Digitally coded squelch
Duplex operation curves
Cellular base antenna systems
Paging 'tree' software
Radio coverage design

AN INTERTEC PUBLICATION

More Console, Less $$$



C-5112

Customizable features in an economical standard console

Do you need custom console features on a limited budget? Vega's Model C-5112 ten-line/four-frequency console offers the economy of a standard-production tone-format radio control console with the expandability of a custom design. External adapters are also available to convert any of the ten lines to DC control.

Just a few of the standard features (many usually optional even on larger, more expensive consoles), include:

- **"SELECTED" switches** for selecting any combination of lines for transmitting and receiving
- **"UNSELECTED" switches** for monitoring any combination of unselected lines
- **TX ALL (simulcast) switch** (selects all lines for both transmit and receive)
- **RX ALL switch** for monitoring all unselected lines
- **Separate speakers** and volume controls for "selected" (TX/RX) and "unselected" (RX-only) audio
- **GROUP SELECT** switch for easy selection of TX/RX line combinations
- **TIMED MUTE** switch (temporarily mutes "unselected" audio)
- **Separate volume controls** for each receive line
- **Instant-PTT switches** for each line
- **Line-activity LEDs** (indicate activity on each line, selected or not)
- **Panel-mounting option modules** (interchangeable options)
- **Heavy-duty 120/240-V_{ac} power supply** (also runs on 12 V_{dc})

Options

When you need just a few custom capabilities in a console, you don't have to buy an expensive, fully customizable design. With the C-5112 you can choose just what you need from the following list of economical options and "FX Series" function expansion modules:

- DCA-3 external three-line adapter for DC-format lines
- Audio-level display and 12/24-hour clock modules
- DTMF encoder module with 16-button pad
- Two-tone, five-tone, and Reach-format sequential encoder modules with pad and display
- Function-tone-generator module; adds eight "wild-card" function tones
- Cross mute with display module
- Goose-neck and desk microphones, headsets, footswitch, etc.

Future options are planned to include a cross-patch module, phone-patch module, telephone module, and ANI display. Other very specialized modules and options are available at reasonable prices. Consult Vega's Specials Department.

Call **1-800-877-1771** (toll-free) today for full details on the C-5112 console.

Circle (4) on Fast Fact Card

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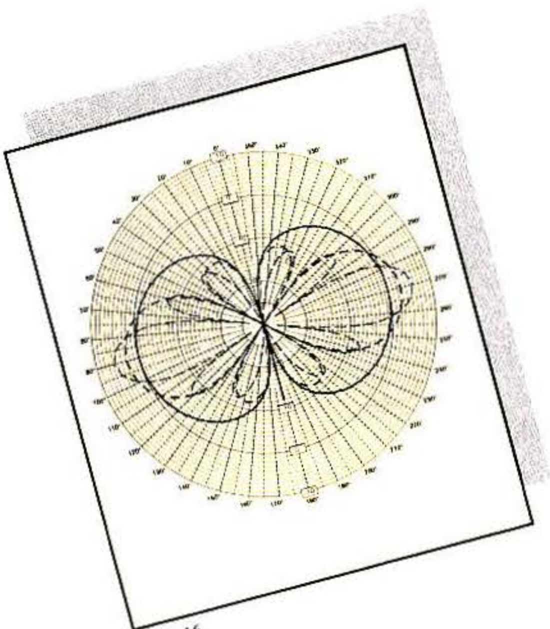
Contents

Mobile Radio Technology

Volume 10, Issue 2

The journal of mobile communications technology

page 10



page 46

features

departments

On the cover: The Hill Air Force Base command center in Utah makes use of combined telephone and radio communications consoles. See article on page 10.

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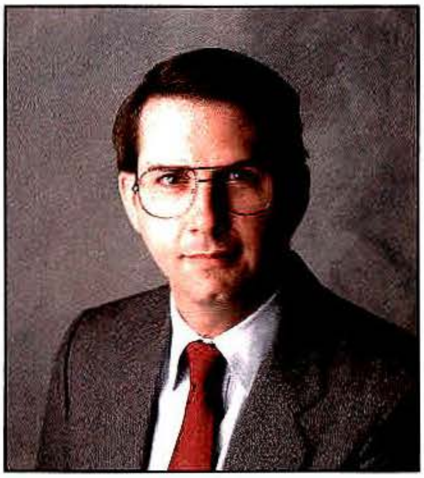
Personal communications



One possible component of personal communications services (PCS), CT2 cordless telephone, has been set back a second time in the United Kingdom. A consortium of companies that was to revive the once-stalled British CT2 service under the Phonepoint banner has halted construction.

CT1 first-generation cordless telephone is presently used mostly in residences. CT2 uses portable telephone handsets to serve customers near base stations in business districts and transportation terminals. It reaches pedestrians, and it does not hand off calls among base stations. Research shows that most users stop walking when they use such a handset.

CT2 handsets only place calls; they do not receive them. Phonepoint handsets were fitted with paging receivers to offset the lack of call-receiving capability.

When system construction was suspended, nearly 2,000 base stations had been installed, and about $150 million had been spent on the project.

One reason the consortium called it quits, at least for now, is the increase in the number of pay telephones in the UK.

Pager and pay telephone

The United States has lots of pay telephones at airports, stores and roadside locations. For someone who wants to spend the least money to keep in touch, it is hard to beat a pager and a pay telephone. The combination of a pager and a pay telephone may not offer the fastest communication, but customers must weigh the value of any extra speed.

Love that phone

If the public is enamored with any particular type of communication, it has to be telephone communication. The telephone may not necessarily be the best way to meet the communication *need*, but in most cases it meets the *want*.

Other alternatives, such as alphanumeric paging (one-way written messages), two-way radio, data (two-way written messages), facsimile, video and computer links, may serve the purpose better and in many cases less expensively.

It will be difficult to develop functions and prices for CT2 and some of the other forms of personal communications to draw large numbers of customers already served by other communications media. Cellular telephone service, for example, does a splendid job of fulfilling the public want and perhaps the need for portable telephone communications.

There are other services that provide portable telephone communications, though: the previously mentioned CT1 cordless telephone, specialized mobile radio, interconnected business and industrial radio, improved mobile telephone service (IMTS) and amateur radio. Each costs less than and has more limitations than cellular portable telephones.

Side issues

Many companies engaging in PCS experiments may fully intend to pursue the business. But there can be other reasons to apply for FCC licenses.

► *Glamour*—New ideas take on a luster that draws attention, and sometimes investment. Some companies announcing an involvement in PCS may be hoping to boost their stock prices just by attaching their names to the new glamour technology.

► *Resale*—Many FCC licenses can be sold for a profit, even when the business associated with the license is not profitable. Speculation has become the rule, not the exception, in many license application proceedings.

► *Spectrum control*—An FCC license grants control over a slice of radio spectrum. Spectrum assigned for one purpose sometimes can be converted to other uses, if the first purpose is unsuccessful or if it becomes obsolete. Sometimes additional services can be placed in the licensed spectrum.

For example, IMTS frequencies have been converted for paging; audio, paging and data services have been added to FM broadcast signals; and a nationwide paging service channel has been converted to a data communication form.

Requests are pending to add private radio services to licensed cellular frequencies and to convert licensed radiodetermination satellite service frequencies to low-earth orbit portable telephone and radiolocation service.

The lesson cannot be lost on PCS license applicants that controlling spectrum usually is worth something and sometimes is worth a lot.

► *The 2GHz conflict*—Incidentally, present occupants of the 2GHz spectrum targeted by applicants for PCS licenses may already have been outmaneuvered.

If enough of these licenses are granted, they may prevent current microwave users in the band from modifying their systems. Spectrum that PCS applicants may not win through outright reallocation they may win by surrounding the present systems, forcing them to move to new frequencies to make system changes that usually become necessary, eventually, with population growth.

FCC "pioneer's preference" requests some PCS applicants have included with their experimental licenses applications may serve to give them title to the 2GHz spectrum, once the matter has been fully sorted out.

Communications mix

The mixture of mobile communications services continues to change. There will be a place for one or more components of PCS, though maybe not as presently envisioned. We expect PCS to take a place alongside the other technologies, rather than replace them.

—*Don Bishop*

Letters to the editor

Bulletin boards:

In response to reader James Creitz's inquiry about bulletin board systems for exchanging technical data, I would like to suggest the Sinclair Radio Labs BBS to your readers.

The Sinclair Radio Labs BBS (716-874-2914) is open to the public and has no charges beyond the price of the call. It offers Sinclair antenna patterns, software and new product information. We, of course, have a conference area for discussing technical problems. To download the software, a user only needs a password, which can be obtained by calling Sinclair at 800-288-2763.

The BBS operates at 300, 1,200 and 2,400 baud. As far as I know, this is the first technical support BBS set up by a land mobile antenna manufacturer.

Andrew Singer
Senior Applications Engineer
Sinclair Radio Labs
Tonawanda, NY

From Fast Fact Cards:

I cut out articles I want for future reference and catalog them by topic in a computer database for easy location. Others' experiences are worth their weight in gold, i.e., don't re-invent the wheel!

The toughest problems facing me on the job include:

- the lack of usable documentation of integrated systems built by others.
- repairing "throw-aways" that are too expensive to throw away.

Allen B. Ferrera
Ferrera & Associates
Santa Rosa, CA

It is hard to stay enthusiastic about repairing RF-based communications equipment since I acquired service responsibilities for computer and telephone systems. Although repairing a radio to the component level is more challenging and rewarding, repairing a computer or key system telephone to the board level seems more logical, economical and easier.

Name withheld
Communications Technician

It is ridiculous to have to try to outmaneuver management and administration to get the job done. The world seems gorged with bean-counters, all of whom are trying to amass power without any knowledge of what they are attempting to control. It is no wonder the Japanese are beating the pants off of us, production-wise and quality-wise.

Name withheld
Communications Technician

The two toughest problems on the job include:

- working on handie-talkies where so much time must be spent disassembling the unit to get to the problem and then reassembling it, compared to the time actually spent working on the problem.

Mobile Radio Technology
The journal of mobile communications technology

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DID-50 Selector Level Interface

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SDI-50 Versatile Interconnect

Operates in simplex, half duplex, or full duplex systems. Local or remote programming. Includes often imitated remote base station operation, and repeater control feature. Uniquely adaptable to changing system requirements. Available with E&M signalling and four wire audio.

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VOX control with electronic voice delay assures smooth operation through repeater systems. Selective signalling, remote base operation, on-board programming keypad.

SSI-68 High Value Simplex Interconnect

Highest feature to price ratio of any simplex interconnect. VOX circuitry controls audio sampling to minimize interruptions. Fully programmable, full featured, low cost.

HDI-68 Half Duplex Interconnect

Designed for repeater applications, packs a lot of features for it's low price. Remote programming, easy installation, smooth operation and high reliability.

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Circle (7) on Fast Fact Card

Make The RIGHT Connection

• having adequate information on schematics in the way of notes, voltages, states and waveforms.

David Goldblatt
Communications Technician
Techco
North Hollywood, CA

The toughest problems on the job are:

• limitations in stocking and storing enough manuals covering the variety of manufacturers and technologies for radios in the field.

• finding qualified technicians and the time to train the technicians and installers who are available.

David L. Ward
Service Technician
A-1 Communications
Poughkeepsie, NY

The toughest problems on the job are:

• keeping up with advancing technology.

• finding quality test equipment at affordable prices.

Lucien A. White
Technician
Highland Communications
Prestonburg, KY

The most difficult problem I have on the job is keeping *all* of our equipment up and running at the same time!

Edward R. Voccola
Director of Communications
Chamberlain Ambulance Service
Shelton, CT

1992 Buyers' Guide

☐ Please turn to page 28 of the December 1991 issue and enter David Clark Company under the "Headsets" and "Intercoms" listings.

☐ Please turn to page 62 and correct the listing for Braley Communication Systems as follows:

3905 Terry-Dianne St.
Beaverton, MI 48612

☐ Please turn to page 72 and correct the listing for Comsearch as follows:

214-680-1000

☐ Please turn to page 72 and correct the listing for CPI Communications as follows:

1186 Commerce St.
Richardson, TX 75081
800-869-9128

☐ Please turn to page 94 and correct the listing for Marketronics as follows:

320 International Parkway
Sunrise, FL 33325
305-846-1011
Fax: 305-846-1672


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Console design responds to dispatching complexity

Consoles place myriad information sources and controls at a dispatcher's fingertips. As the number of communications circuits increases, console designs become more flexible through programmable software.

By Bryna Shuchat

Emergency communications systems focus on the dispatcher. As more elements are combined into these systems, such as telephones, two-way radios, automatic vehicle location, mapping devices and other components, control consoles have been developed to help dispatchers to operate the system.

The problem is that each of these elements traditionally has had its own control console. Under this configuration, telephone and radio functions were separated.

Typically, telephone consoles were large 1A2 key systems with multibutton capability. The radio console usually was proprietary to the manufacturer and designed specifically to work with the manufacturer's two-way mobile radios.

Telephone and radio equipment has been configured with separate consoles because, although they are used in conjunction with one another at the operational level, at the vendor level the manufacturing is separated.

In an attempt to overcome the problem, radio manufacturers have adapted their radios for telephone requirements, and telephone manufacturers have adapted their telephones for radio use.

Shuchat is advertising and project coordinator at Positron Industries, Montreal, Quebec. The company manufactures a communication console that is used as an example in this article.

The Hill Air Force Base command center in Utah makes use of combined telephone and radio communications consoles.

Figure 1 below shows a block diagram of a more effective alternative, a combination telephone and radio communications console. The operator's functional requirements are reflected in the configuration and programmability of the console module. The electronics in the module and in the backroom equipment control telephone and radio equipment according to the operator's needs.

The console module connects with a turret interface controller (TIC) and concentrator in the back room. The TIC houses a central processing unit (CPU) and four circuit board cards that process analog signals. These analog cards amplify the operator's voice and match

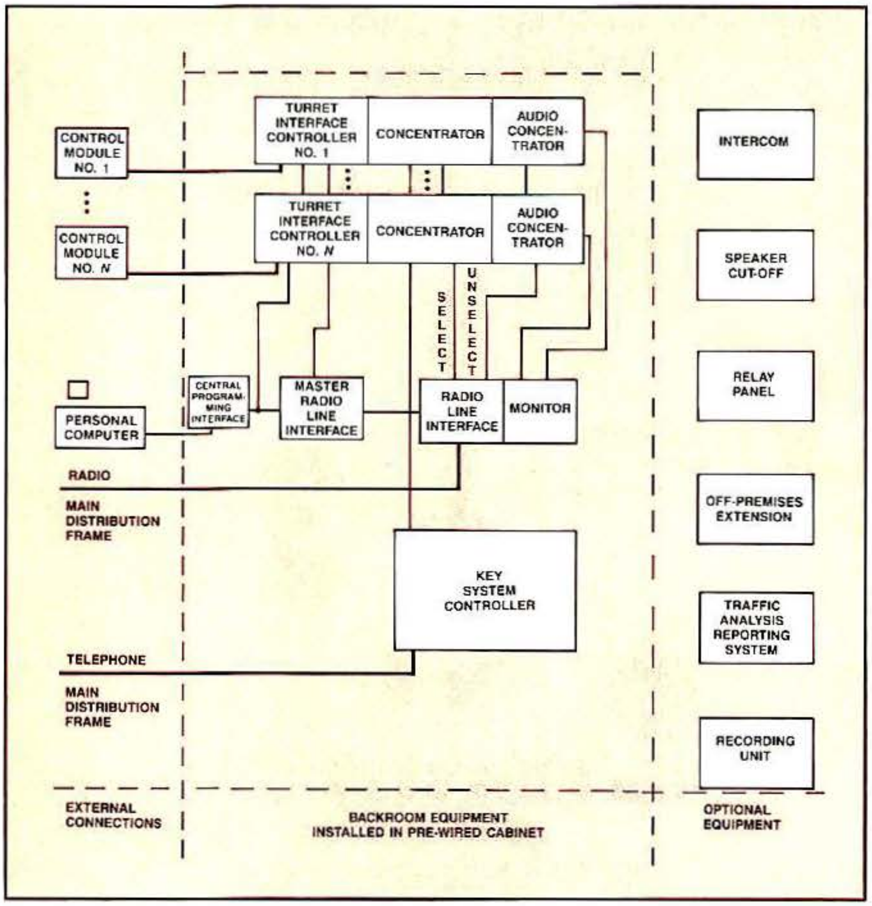


Figure 1. A block diagram of a combination telephone and radio communications console.

necessary line impedances.

Two of the analog cards provide the voice path for one or more handsets or headsets the operator uses to speak over the telephone and radio circuits. The other two analog cards provide the voice path for a conference call among distant parties. Another word for a conference call is a patch, a holdover from the early days when voice paths were established manually by plugging jumper cables into sockets.

The concentrator is a large switching matrix. Radio interface and telephone interface outputs from the key signaling converter are routed to the concentrator. The operator can select any line circuit assigned to the console module from circuits terminated to the concentrators.

The master radio line interface (RLI) provides a method of monitoring and polling the RLI shelves and TIC/concentrator shelves installed within the system through one of its local area networks. An additional local area network of the master RLI communicates with the central programming interface, which in turn communicates to the TIC/concentrator shelves and the personal computer.

The console can perform two simultaneous patches of any combination of six telephone or radio circuits or both. This capability is useful when a mobile operator wants to establish a conference with someone who does not have access to radio communications, or vice versa. The dispatcher makes the patch by selecting line circuits from the concentrator field.

Abbreviations

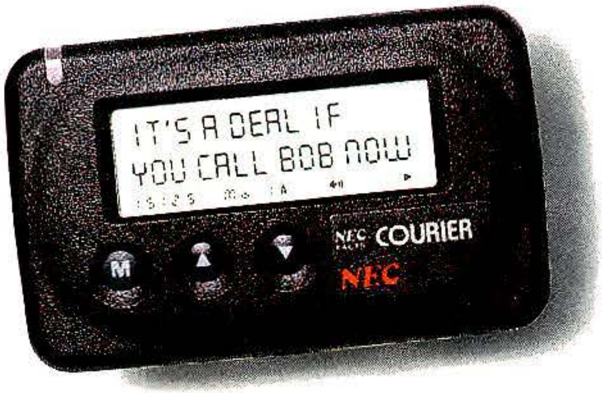
CM—control module
CPU—central processing unit
DIP—dual in-line package
KSC—key signaling converter
MDS—main distribution frame

OPX—off-premises extension
RLI—radio line interface
TIC—turret interface controller

The dispatcher's function is to establish the patch between the remote parties. Once the patch is established, the dispatcher can exit from the circuit by depressing the associated patch key. Then the dispatcher is free for other activities, including processing other calls. The dispatcher may rejoin the patch by depressing the same patch button.

Once the dispatcher is removed from the patch, voice detection circuitry monitors the line circuits included in the patch and provides a visual indication of speech activity on the associated patch key.

Each patch operation may be assigned as either an automatic disconnect or a manual disconnect after a preset interval has elapsed. In the automatic mode,

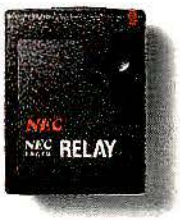


Some messages can't wait until you get back to the office. You can imagine the scenario. You're out on the road and your pager goes off. You check the screen and don't recognize the telephone number. Figuring there's no rush, you decide to wait until you get back to the office to find out who called.

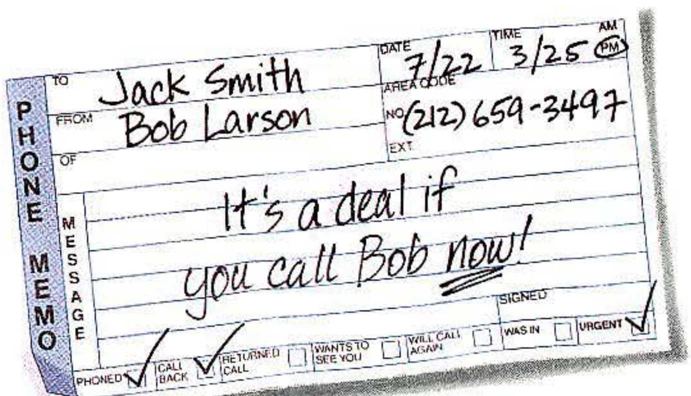
Sooner.

But with NEC's Facts Courier™ pager, you can still take the message when you can't take the call. It spells out messages of up to 32 characters on its easy-to-read, illuminated screen. Its 6500-character memory base provides you with push-button access to as many as 40 messages, addresses, memos or reminders.

Another NEC pager worth checking out is the Facts Relay.™ It can store up to 16 messages of up to 20 characters each (maximum storage capacity of 200 characters). And its 12-character illuminated display is easy-to-read—even in the dark.



No matter where your business takes you, NEC's new Facts family of pagers will keep your messages coming. All are engineered with the quality and reliability you've come to expect from NEC, a world leader in computers and communications. Make sure you get armed with the Facts. The sooner the better. Just call 1-800-225-5664.



Or later.

NEC

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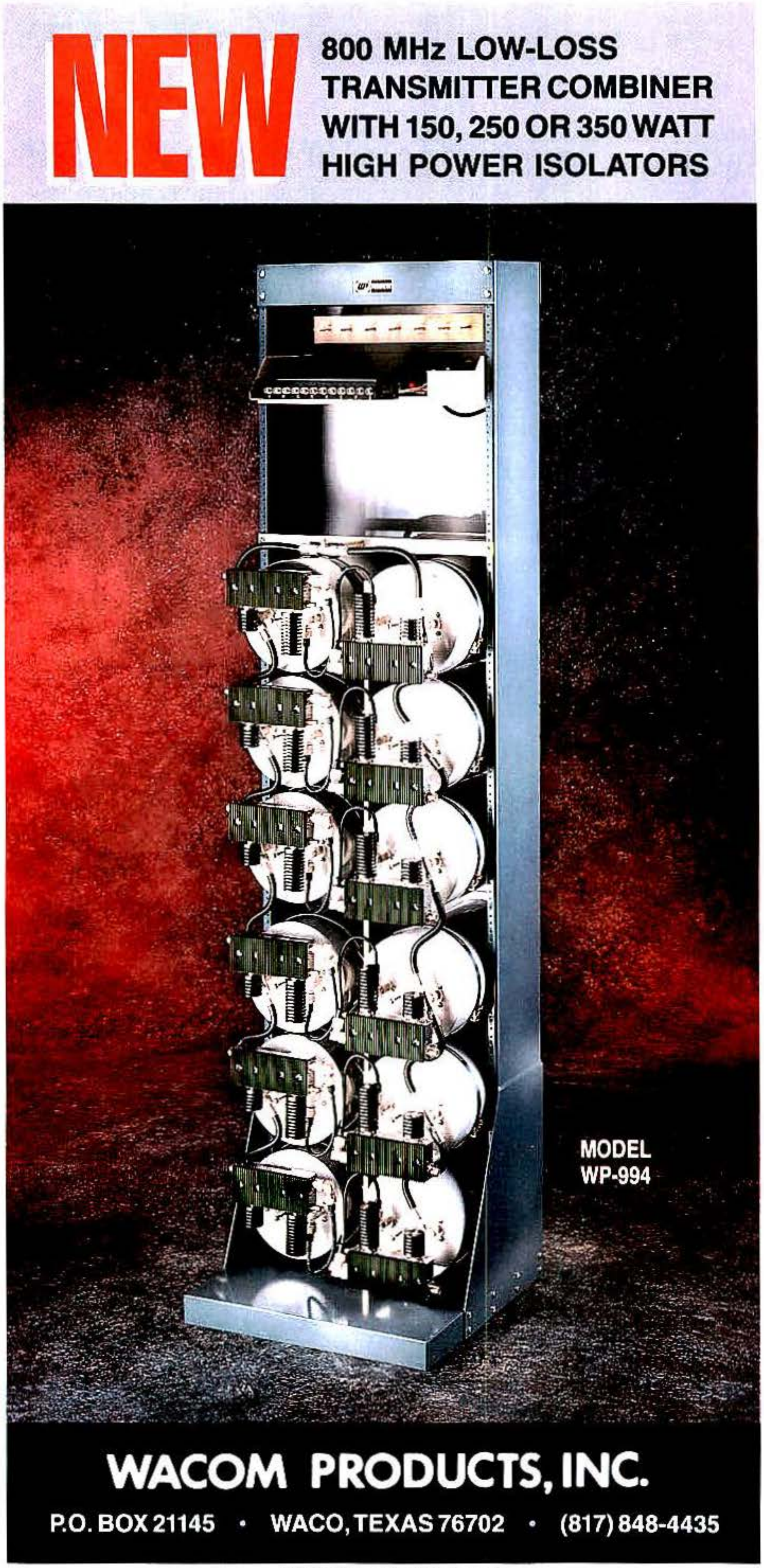


the system clears the patch or liberates the line circuits when the last party in the patch hangs up. In the manual mode, a flashing light on the patch key alerts the operator when the last party hangs up. The operator can then clear the patch manually.

Software programmability

Virtually all contemporary and sophisticated communications equipment relies on software rather than hardware to change functions.

To implement software control of the communications console functions, each control module terminates to its own control shelf. The control shelf has a combination TIC/concentrator, and thus its own CPU.

Each of the TIC/concentrator shelves is daisy chained through a second local area network to connect to the central programming interface.

From the central programming interface, an IBM PC or an IBM PC-compatible personal computer is terminated to an RS-232 port, which is used to edit or download one or more console's databases via central programming software.

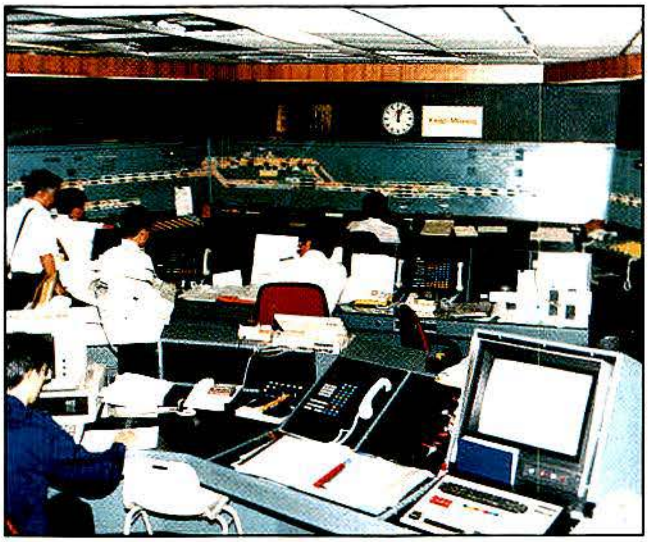
Redundancy

To prevent the loss of any one component from rendering the system useless, one or more key elements are duplicated in separate locations within the system shown in Figure 1. For example, redundant central processing units are included in each console workstation and its corresponding control shelves, which house the voice and data switching control cards. The control shelves are mounted in one or more prewired cabinets that may be installed within 1,000 feet from the consoles. Greater distances require the use of an off-premises extension system.

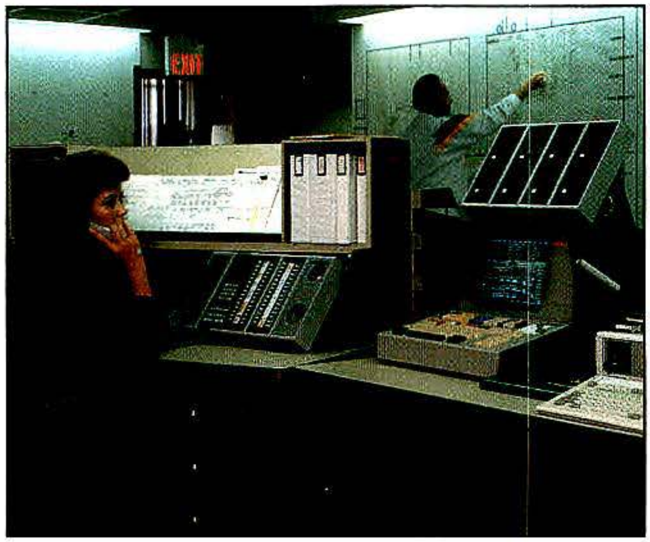
Each TIC unit includes a CPU with 64K of backup computer memory. The TIC CPU contains the database information programmed by the central programming software. With the database information residing in each TIC's CPU, the failure of one central processing unit affects no more than one console workstation or radio circuit.

Modular design

To help users expand their systems with minimum effort, consoles can be



The Kowloon-Canton Railway control center in Hong Kong uses computers along with telephone and radio communications consoles to direct railcar movements.



Arizona Public Service integrates its private land mobile radio system with telephone communications using a combined telephone and radio communications console.

designed from modules that may be added and subtracted to change system capacity. Whereas programmability makes software changes easy, modular design makes hardware changes easy.

When the need arises to control additional telephone or radio line circuits, the system allows expansion by adding control cards to existing shelves.

The system may be expanded to include as many as 240 button keys, which may be assigned to access telephone or radio line circuits, speed dials or special functions.

Maintenance technicians, whether employed by the console owner or hired under contract, do not require special tooling to replace a defective card or

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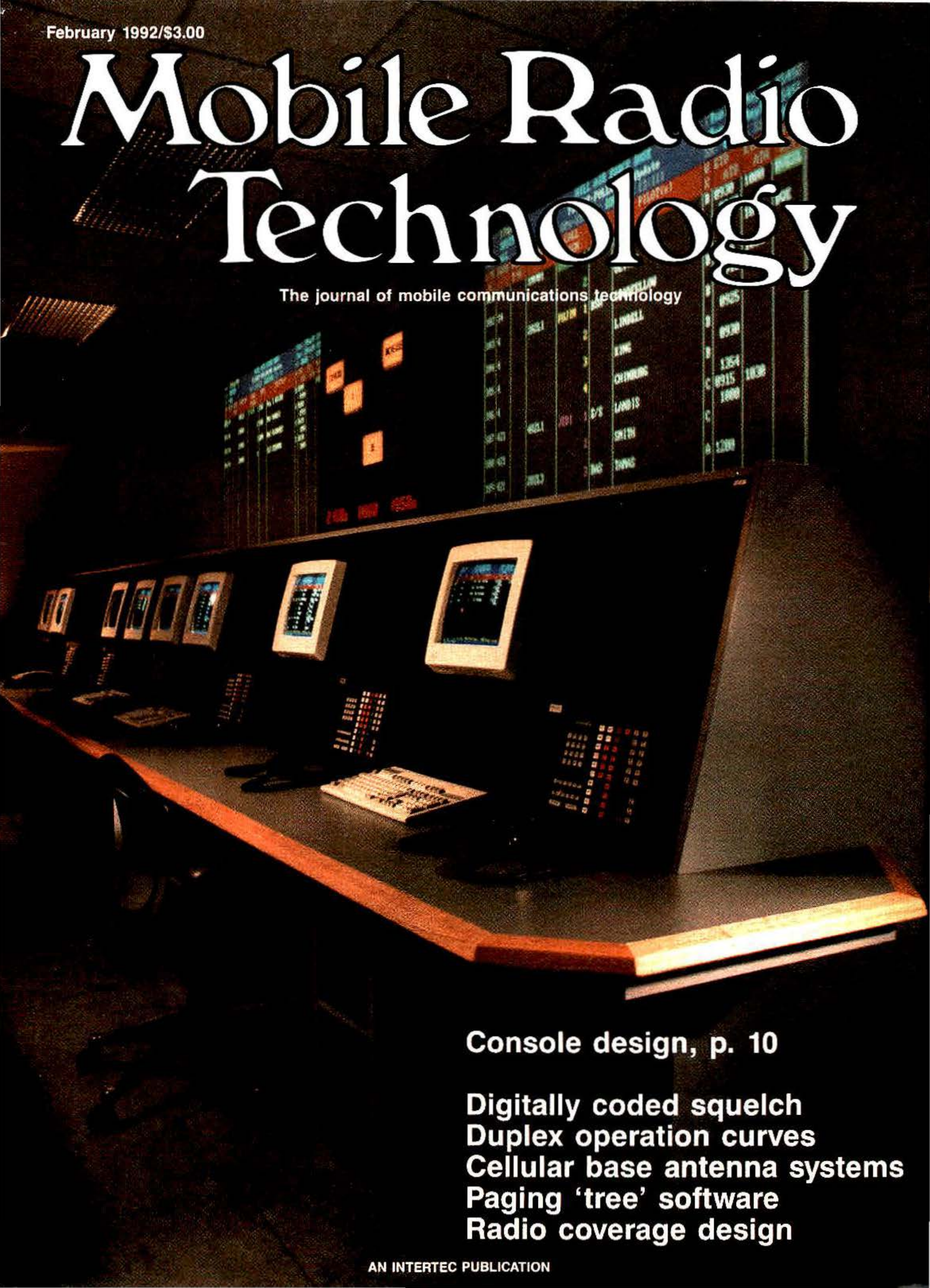

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Radio coverage design

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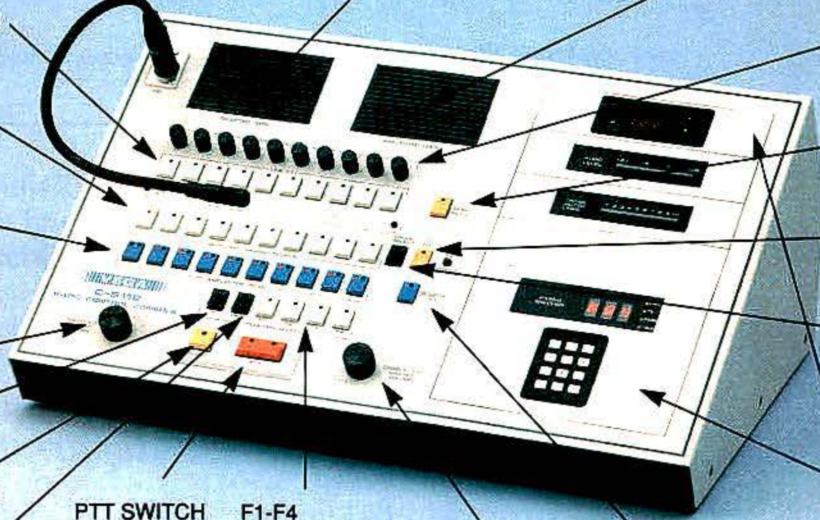

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- Goose-neck and desk microphones, headsets, footswitch, etc.

Future options are planned to include a cross-patch module, phone-patch module, telephone module, and ANI display. Other very specialized modules and options are available at reasonable prices. Consult Vega's Specials Department.

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Contents

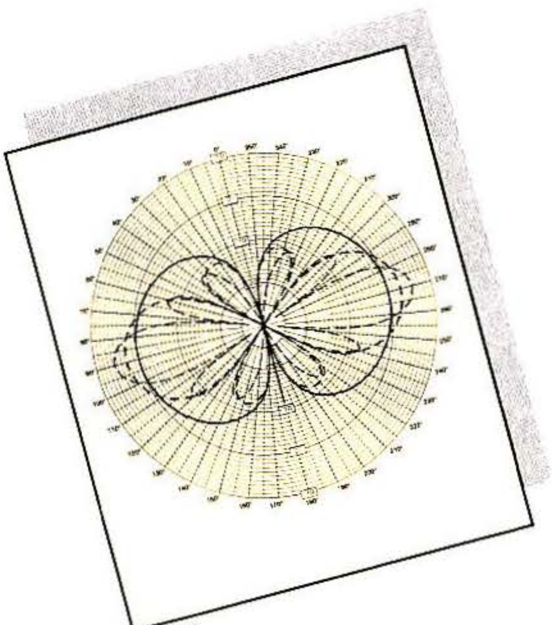
Mobile Radio Technology

Volume 10, Issue 2 The journal of mobile communications technology

features

departments

page 10



page 46

On the cover: The Hill Air Force Base command center in Utah makes use of combined telephone and radio communications consoles. See article on page 10.

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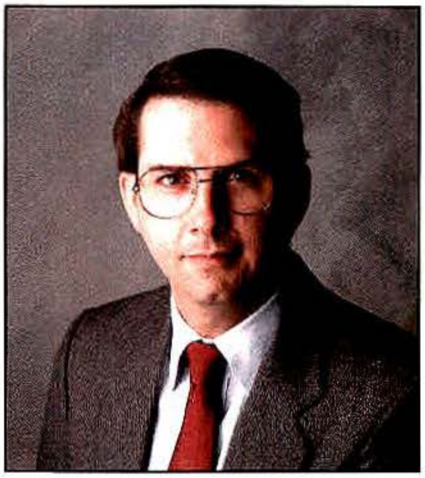
Editorial

Personal communications



One possible component of personal communications services (PCS), CT2 cordless telephone, has been set back a second time in the United Kingdom. A consortium of companies that was to revive the once-stalled British CT2 service under the Phonepoint banner has halted construction.

CT1 first-generation cordless telephone is presently used mostly in residences. CT2 uses portable telephone handsets to serve customers near base stations in business districts and transportation terminals. It reaches pedestrians, and it does not hand off calls among base stations. Research shows that most users stop walking when they use such a handset.

CT2 handsets only place calls; they do not receive them. Phonepoint handsets were fitted with paging receivers to offset the lack of call-receiving capability.

When system construction was suspended, nearly 2,000 base stations had been installed, and about $150 million had been spent on the project.

One reason the consortium called it quits, at least for now, is the increase in the number of pay telephones in the UK.

Pager and pay telephone

The United States has lots of pay telephones at airports, stores and roadside locations. For someone who wants to spend the least money to keep in touch, it is hard to beat a pager and a pay telephone. The combination of a pager and a pay telephone may not offer the fastest communication, but customers must weigh the value of any extra speed.

Love that phone

If the public is enamored with any particular type of communication, it has to be telephone communication. The telephone may not necessarily be the best way to meet the communication *need*, but in most cases it meets the *want*.

Other alternatives, such as alphanumeric paging (one-way written messages), two-way radio, data (two-way written messages), facsimile, video and computer links, may serve the purpose better and in many cases less expensively.

It will be difficult to develop functions and prices for CT2 and some of the other forms of personal communications to draw large numbers of customers already served by other communications media. Cellular telephone service, for example, does a splendid job of fulfilling the public want and perhaps the need for portable telephone communications.

There are other services that provide portable telephone communications, though: the previously mentioned CT1 cordless telephone, specialized mobile radio, interconnected business and industrial radio, improved mobile telephone service (IMTS) and amateur radio. Each costs less than and has more limitations than cellular portable telephones.

Side issues

Many companies engaging in PCS experiments may fully intend to pursue the business. But there can be other reasons to apply for FCC licenses.

► *Glamour*—New ideas take on a luster that draws attention, and sometimes investment. Some companies announcing an involvement in PCS may be hoping to boost their stock prices just by attaching their names to the new glamour technology.

► *Resale*—Many FCC licenses can be sold for a profit, even when the business associated with the license is not profitable. Speculation has become the rule, not the exception, in many license application proceedings.

► *Spectrum control*—An FCC license grants control over a slice of radio spectrum. Spectrum assigned for one purpose sometimes can be converted to other uses, if the first purpose is unsuccessful or if it becomes obsolete. Sometimes additional services can be placed in the licensed spectrum.

For example, IMTS frequencies have been converted for paging; audio, paging and data services have been added to FM broadcast signals; and a nationwide paging service channel has been converted to a data communication form.

Requests are pending to add private radio services to licensed cellular frequencies and to convert licensed radiodetermination satellite service frequencies to low-earth orbit portable telephone and radiolocation service.

The lesson cannot be lost on PCS license applicants that controlling spectrum usually is worth something and sometimes is worth a lot.

► *The 2GHz conflict*—Incidentally, present occupants of the 2GHz spectrum targeted by applicants for PCS licenses may already have been outmaneuvered.

If enough of these licenses are granted, they may prevent current microwave users in the band from modifying their systems. Spectrum that PCS applicants may not win through outright reallocation they may win by surrounding the present systems, forcing them to move to new frequencies to make system changes that usually become necessary, eventually, with population growth.

FCC "pioneer's preference" requests some PCS applicants have included with their experimental licenses applications may serve to give them title to the 2GHz spectrum, once the matter has been fully sorted out.

Communications mix

The mixture of mobile communications services continues to change. There will be a place for one or more components of PCS, though maybe not as presently envisioned. We expect PCS to take a place alongside the other technologies, rather than replace them.

—Don Bishop

PRIVACY NEWS from transcrypt

Volume 1, No. 5

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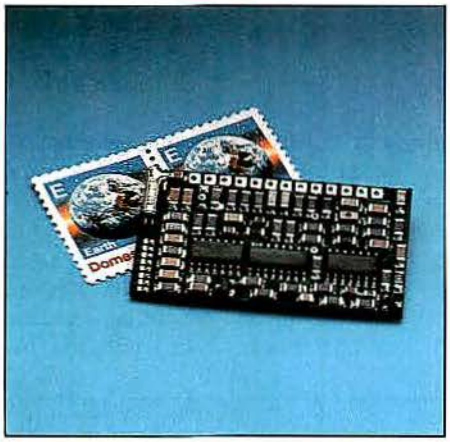

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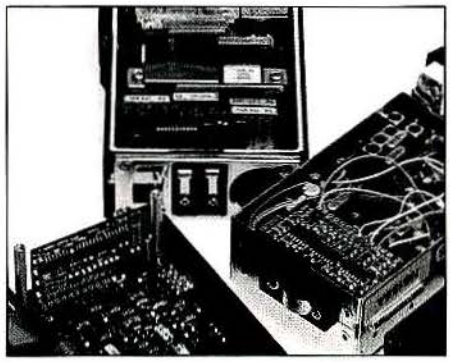

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Letters to the editor

Bulletin boards:

In response to reader James Creitz's inquiry about bulletin board systems for exchanging technical data, I would like to suggest the Sinclair Radio Labs BBS to your readers.

The Sinclair Radio Labs BBS (716-874-2914) is open to the public and has no charges beyond the price of the call. It offers Sinclair antenna patterns, software and new product information. We, of course, have a conference area for discussing technical problems. To download the software, a user only needs a password, which can be obtained by calling Sinclair at 800-288-2763.

The BBS operates at 300, 1,200 and 2,400 baud. As far as I know, this is the first technical support BBS set up by a land mobile antenna manufacturer.

Andrew Singer
Senior Applications Engineer
Sinclair Radio Labs
Tonawanda, NY

From Fast Fact Cards:

I cut out articles I want for future reference and catalog them by topic in a computer database for easy location. Others' experiences are worth their weight in gold, i.e., don't re-invent the wheel!

The toughest problems facing me on the job include:

• the lack of usable documentation of integrated systems built by others.

• repairing "throw-aways" that are too expensive to throw away.

Allen B. Ferrera
Ferrera & Associates
Santa Rosa, CA

It is hard to stay enthusiastic about repairing RF-based communications equipment since I acquired service responsibilities for computer and telephone systems. Although repairing a radio to the component level is more challenging and rewarding, repairing a computer or key system telephone to the board level seems more logical, economical and easier.

Name withheld
Communications Technician

It is ridiculous to have to try to outmaneuver management and administration to get the job done. The world seems gorged with bean-counters, all of whom are trying to amass power without any knowledge of what they are attempting to control. It is no wonder the Japanese are beating the pants off of us, production-wise and quality-wise.

Name withheld
Communications Technician

The two toughest problems on the job include:

• working on handie-talkies where so much time must be spent disassembling the unit to get to the problem and then reassembling it, compared to the time actually spent working on the problem.

Mobile Radio Technology
The journal of mobile communications technology

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Make The RIGHT Connection

• having adequate information on schematics in the way of notes, voltages, states and waveforms.

David Goldblatt
Communications Technician
Techco
North Hollywood, CA

The toughest problems on the job are:

• limitations in stocking and storing enough manuals covering the variety of manufacturers and technologies for radios in the field.

• finding qualified technicians and the time to train the technicians and installers who are available.

David L. Ward
Service Technician
A-1 Communications
Poughkeepsie, NY

The toughest problems on the job are:

• keeping up with advancing technology.

• finding quality test equipment at affordable prices.

Lucien A. White
Technician
Highland Communications
Prestonburg, KY

The most difficult problem I have on the job is keeping *all* of our equipment up and running at the same time!

Edward R. Voccola
Director of Communications
Chamberlain Ambulance Service
Shelton, CT

1992 Buyers' Guide

☐ Please turn to page 28 of the December 1991 issue and enter David Clark Company under the "Headsets" and "Intercoms" listings.

☐ Please turn to page 62 and correct the listing for Braley Communication Systems as follows:

3905 Terry-Dianne St.
Beaverton, MI 48612

☐ Please turn to page 72 and correct the listing for Comsearch as follows:

214-680-1000

☐ Please turn to page 72 and correct the listing for CPI Communications as follows:

1186 Commerce St.
Richardson, TX 75081
800-869-9128

☐ Please turn to page 94 and correct the listing for Marketronics as follows:

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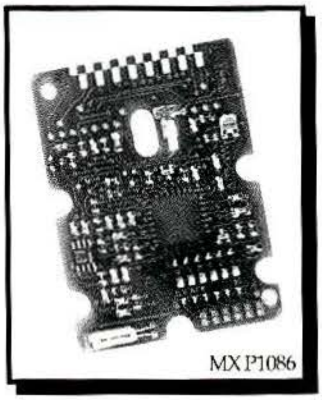
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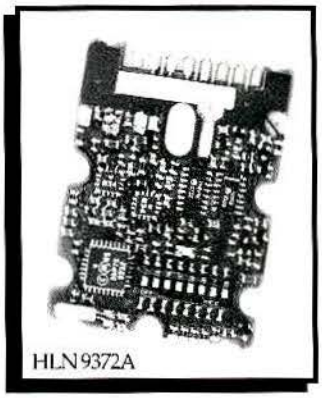
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FLIGHT-FOLLOWING Update
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Console design responds to dispatching complexity

Consoles place myriad information sources and controls at a dispatcher's fingertips. As the number of communications circuits increases, console designs become more flexible through programmable software.

By Bryna Shuchat

Emergency communications systems focus on the dispatcher. As more elements are combined into these systems, such as telephones, two-way radios, automatic vehicle location, mapping devices and other components, control consoles have been developed to help dispatchers to operate the system.

The problem is that each of these elements traditionally has had its own control console. Under this configuration, telephone and radio functions were separated.

Typically, telephone consoles were large 1A2 key systems with multibutton capability. The radio console usually was proprietary to the manufacturer and designed specifically to work with the manufacturer's two-way mobile radios.

Telephone and radio equipment has been configured with separate consoles because, although they are used in conjunction with one another at the operational level, at the vendor level the manufacturing is separated.

In an attempt to overcome the problem, radio manufacturers have adapted their radios for telephone requirements, and telephone manufacturers have adapted their telephones for radio use.

Shuchat is advertising and project coordinator at Positron Industries, Montreal, Quebec. The company manufactures a communication console that is used as an example in this article.

The Hill Air Force Base command center in Utah makes use of combined telephone and radio communications consoles.

Figure 1 below shows a block diagram of a more effective alternative, a combination telephone and radio communications console. The operator's functional requirements are reflected in the configuration and programmability of the console module. The electronics in the module and in the backroom equipment control telephone and radio equipment according to the operator's needs.

The console module connects with a turret interface controller (TIC) and concentrator in the back room. The TIC houses a central processing unit (CPU) and four circuit board cards that process analog signals. These analog cards amplify the operator's voice and match

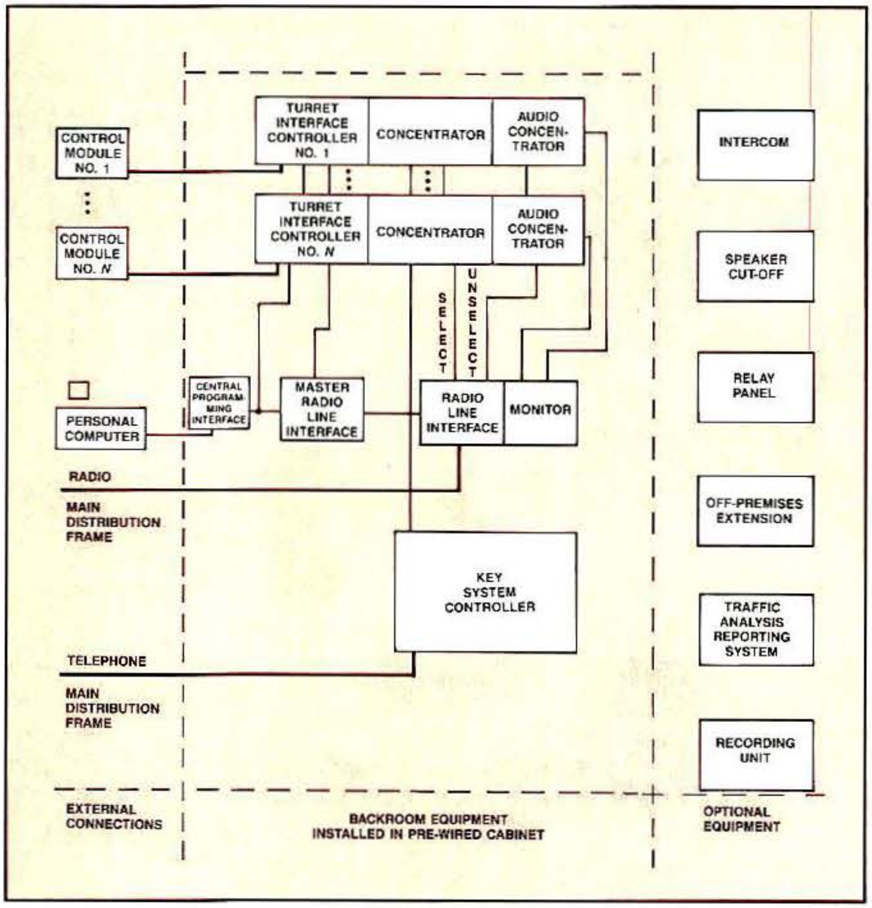


Figure 1. A block diagram of a combination telephone and radio communications console.

necessary line impedances.

Two of the analog cards provide the voice path for one or more handsets or headsets the operator uses to speak over the telephone and radio circuits. The other two analog cards provide the voice path for a conference call among distant parties. Another word for a conference call is a patch, a holdover from the early days when voice paths were established manually by plugging jumper cables into sockets.

The concentrator is a large switching matrix. Radio interface and telephone interface outputs from the key signaling converter are routed to the concentrator. The operator can select any line circuit assigned to the console module from circuits terminated to the concentrators.

The master radio line interface (RLI) provides a method of monitoring and polling the RLI shelves and TIC/concentrator shelves installed within the system through one of its local area networks. An additional local area network of the master RLI communicates with the central programming interface, which in turn communicates to the TIC/concentrator shelves and the personal computer.

The console can perform two simultaneous patches of any combination of six telephone or radio circuits or both. This capability is useful when a mobile operator wants to establish a conference with someone who does not have access to radio communications, or vice versa. The dispatcher makes the patch by selecting line circuits from the concentrator field.

Abbreviations

CM—control module
CPU—central processing unit
DIP—dual in-line package
KSC—key signaling converter
MDS—main distribution frame

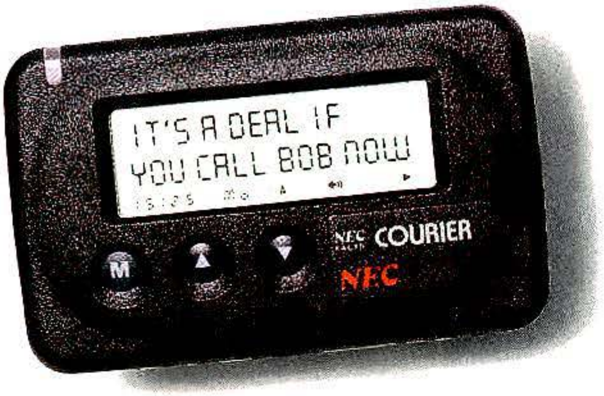
OPX—off-premises extension
RLI—radio line interface
TIC—turret interface controller

The dispatcher's function is to establish the patch between the remote parties. Once the patch is established, the dispatcher can exit from the circuit by depressing the associated patch key. Then the dispatcher is free for other activities, including processing other calls. The dispatcher may rejoin the patch by depressing the same patch button.

Once the dispatcher is removed from the patch, voice detection circuitry monitors the line circuits included in the patch and provides a visual indication of speech activity on the associated patch key.

Each patch operation may be assigned as either an automatic disconnect or a manual disconnect after a preset interval has elapsed. In the automatic mode,

C&C Computers and Communications



Sooner.

Some messages can't wait until you get back to the office. You can imagine the scenario. You're out on the road and your pager goes off. You check the screen and don't recognize the telephone number. Figuring there's no rush, you decide to wait until you get back to the office to find out who called.

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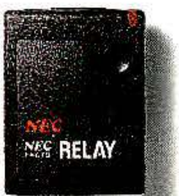
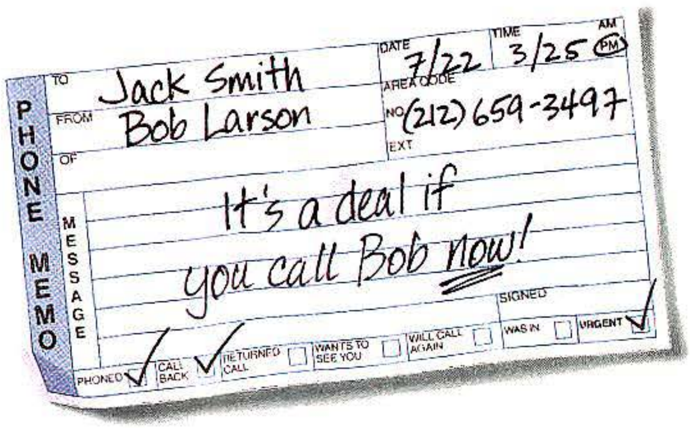


No matter where your business takes you, NEC's new Facts family of pagers will keep your messages coming. All are engineered with the quality and reliability you've come to expect from NEC, a world leader in computers and communications. Make sure you get armed with the Facts. The sooner the better. Just call 1-800-225-5664.



Or later.

NEC

Circle (11) on Fast Fact Card

the system clears the patch or liberates the line circuits when the last party in the patch hangs up. In the manual mode, a flashing light on the patch key alerts the operator when the last party hangs up. The operator can then clear the patch manually.

Software programmability

Virtually all contemporary and sophisticated communications equipment relies on software rather than hardware to change functions.

To implement software control of the communications console functions, each control module terminates to its own control shelf. The control shelf has a combination TIC/concentrator, and thus its own CPU.

Each of the TIC/concentrator shelves is daisy chained through a second local area network to connect to the central programming interface.

From the central programming interface, an IBM PC or an IBM PC-compatible personal computer is terminated to an RS-232 port, which is used to edit or download one or more console's databases via central programming software.

Redundancy

To prevent the loss of any one component from rendering the system useless, one or more key elements are duplicated in separate locations within the system shown in Figure 1. For example, redundant central processing units are included in each console workstation and its corresponding control shelves, which house the voice and data switching control cards. The control shelves are mounted in one or more prewired cabinets that may be installed within 1,000 feet from the consoles. Greater distances require the use of an off-premises extension system.

Each TIC unit includes a CPU with 64K of backup computer memory. The TIC CPU contains the database information programmed by the central programming software. With the database information residing in each TIC's CPU, the failure of one central processing unit affects no more than one console workstation or radio circuit.

Modular design

To help users expand their systems with minimum effort, consoles can be

We interrupt this magazine to bring you some important messages.

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C-Mark II single-window ANI decoder-Display. List price $995.

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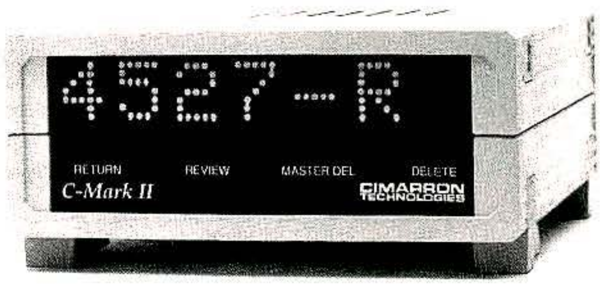

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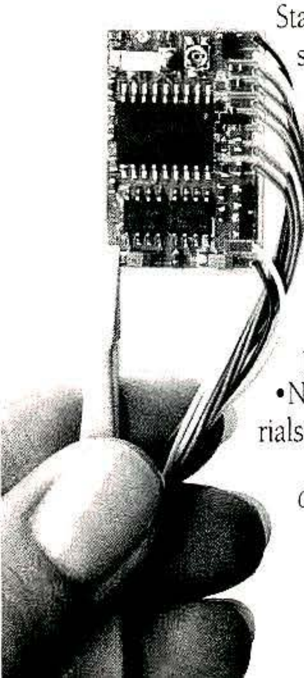

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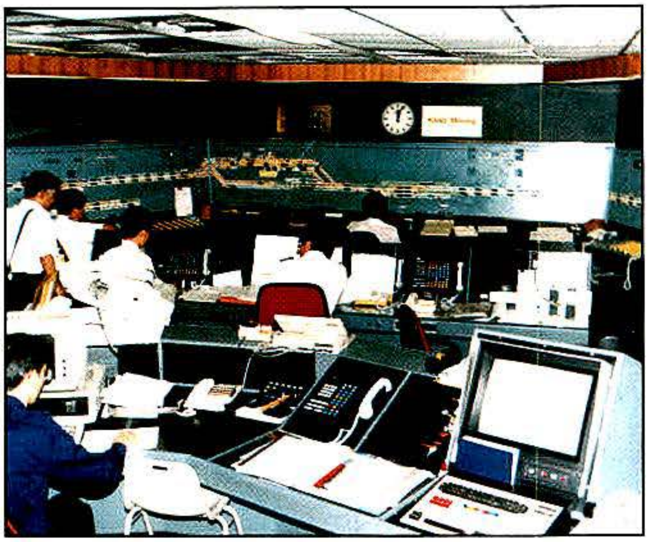

The Kowloon-Canton Railway control center in Hong Kong uses computers along with telephone and radio communications consoles to direct railcar movements.

Arizona Public Service integrates its private land mobile radio system with telephone communications using a combined telephone and radio communications console.

designed from modules that may be added and subtracted to change system capacity. Whereas programmability makes software changes easy, modular design makes hardware changes easy.

When the need arises to control additional telephone or radio line circuits, the system allows expansion by adding control cards to existing shelves.

The system may be expanded to include as many as 240 button keys, which may be assigned to access telephone or radio line circuits, speed dials or special functions.

Maintenance technicians, whether employed by the console owner or hired under contract, do not require special tooling to replace a defective card or

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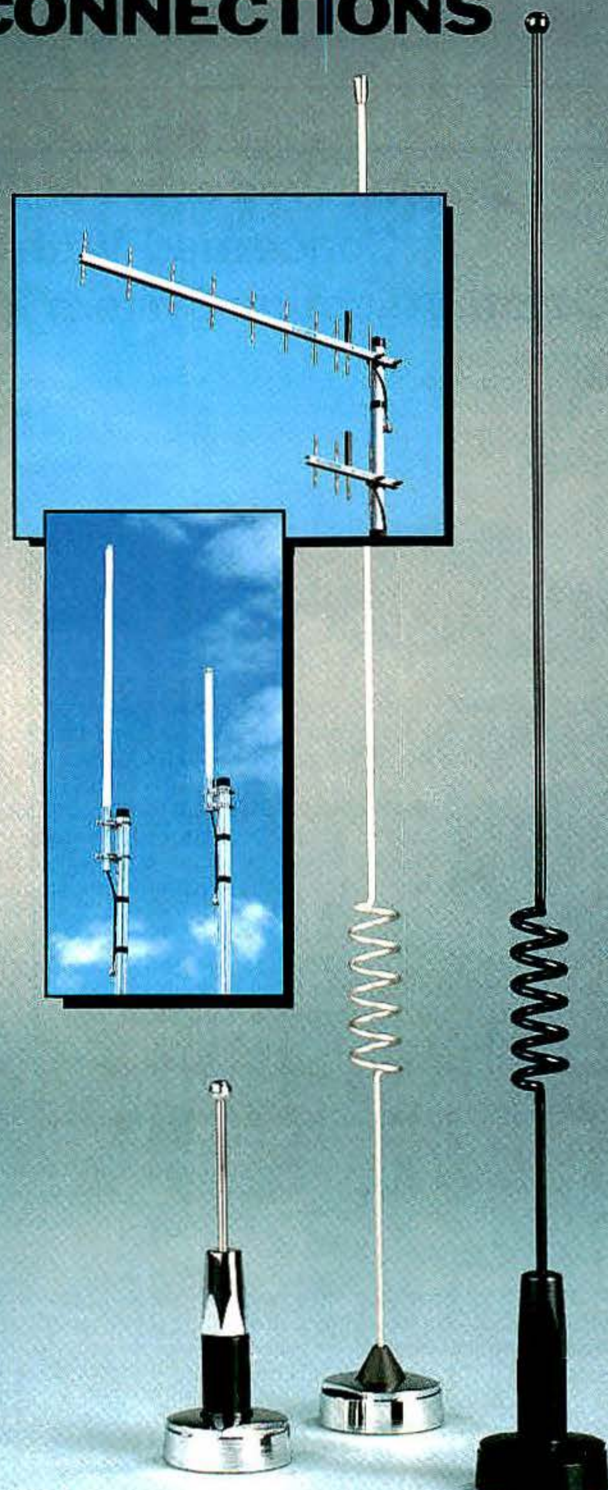

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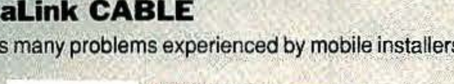

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module. Units installed in place of a defective card or module do not require reprogramming because the console workstation's database is retained by the TIC CPU.

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Where consoles with dedicated switches and hardware connections are not easily modified, consoles with programmable software allow lines and functions to be tailored individually. Programmability revolutionizes the way in which dispatch consoles are configured for large and small applications. At the height of flexibility, any button can be programmed to control any function or to select any telephone or radio line.

The console may be used to operate relay circuits, commonly referred to as contact closures. Contact closures allow a console operator to control external devices remotely. Contact closures are configured by setting DIP switches on the audio concentrator card.

One side of a cable pair to the remote device is terminated to one side of the relay coil. The other side of the relay coil is powered by a local power source.

The second wire from the cable pair is connected as a return to indicate the status of the function. Thus, when the console operator depresses the assigned button key, the following occurs:

- A virtual ground is applied through the audio concentrator card to the relay coil's wire lead, turning on the key's green light-emitting diode (LED). Once the relay is energized, its contacts operate the external device connected to it. Examples of remote functions include opening and closing doors, causing bells to sound and activating alarm indications.
- While the relay is energized, the button key's red LED illuminates to give the console operator a visual status indication of the contacts.

Some agencies build off-site facilities to use if the main facility is evacuated.

Off-site facilities

Some agencies build off-site facilities to use if the main facility is evacuated. One or more consoles may be located at any distance from the equipment room to allow the same access and control over the telephone and radio channels. Because the off-site consoles look the same and operate the same as consoles at the main site, dispatchers can work as efficiently off-site without retraining.

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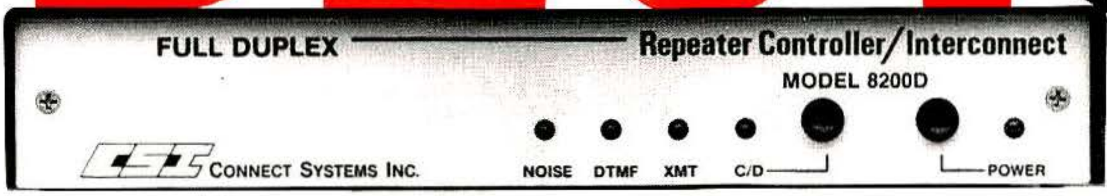

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Digitally coded squelch: Picking the right device

Part 4—Many vendors offer board-level DCS encoder-decoders. Some have done their homework; others attempt to cop a good grade by cheating on the exam. Bench and field tests help to confirm your selection.*

By Mark Nadir

Using the basic information about digitally coded squelch as explained in the first three parts of this article series, you are ready to make a series of tests. These tests help you to evaluate a single DCS device, such as in an original equipment manufacturer (OEM) radio transceiver, or to compare multiple devices, such as several board-level DCS products you may be considering purchasing.

After carefully following the instructions for installing the DCS encoder-decoder into the radio, you can begin evaluating the device.

Nadir is president of Globestar Technology, Ft. Lauderdale, FL; telephone 305-763-1569. The company specializes in the design and implementation of digital radio systems for clients worldwide.

Encoder evaluation

Make sure your service monitor is DCS-capable. Some older monitors require modifications to obtain the low-frequency audio response needed for DCS operation. If in doubt, contact the manufacturer.

The DCS encoder test is simple. Key the radio transmitter and observe the transmitted DCS waveform on the service monitor. If the monitor waveform closely resembles Figure 1 below, then the transmitter's low-frequency response is adequate.

But if the waveform resembles Figure 2 below, the radio modulator does not have enough low-frequency coupling. Increasing the value of the coupling capacitor may help.

Despite the different appearances of Figures 1 and 2, the same filter, excited by the same binary pattern, generated both figures.

The filter used to generate Figure 2 has an input coupling capacitor that creates a high-pass filter with a corner frequency at about 5Hz. Even with a cutoff this low, the filter strips vital data

*In fairness to a majority of board-level DCS product vendors, it should be said that their task is substantially more difficult than that of an original equipment manufacturer (OEM) vendor that makes a DCS feature available in its radio product.

The OEM vendor enjoys an advantage because the DCS design is customized to work in one product. On the other hand, the board-level vendor must design a universal DCS product to work in multiple radios.

Despite the OEM vendor's advantage, most OEM DCS designers will, in a moment of candor, admit to at least one serious faux pas when it comes to digital squelch.

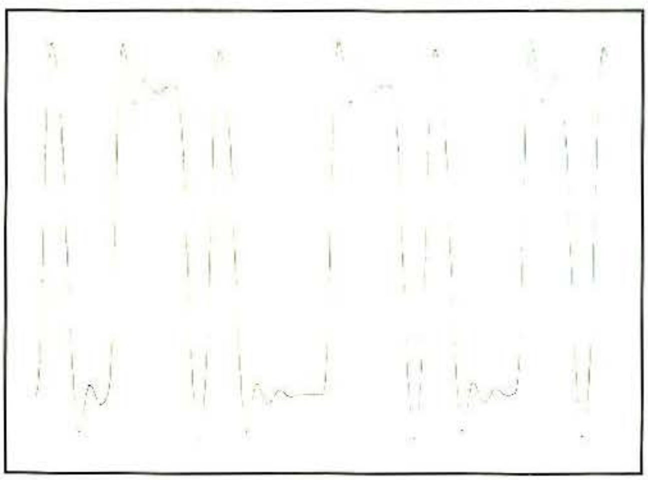


Figure 1. The DCS encoder test is simple. Key the radio transmitter and observe the transmitted DCS waveform on the service monitor. If the monitor waveform closely resembles this diagram, then the transmitter's low-frequency response is adequate.

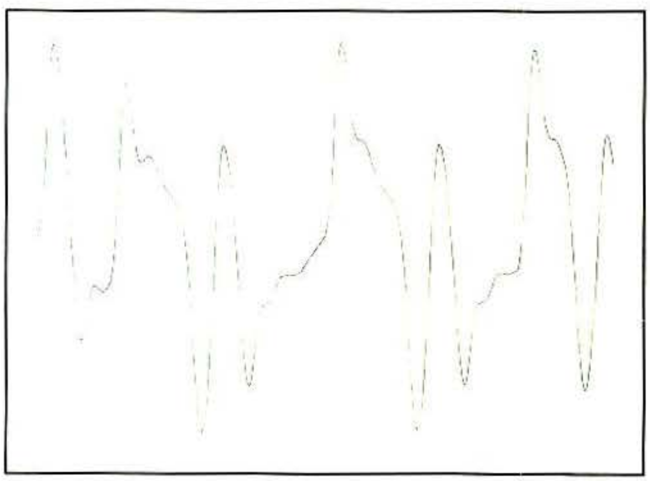


Figure 2. If the DCS waveform resembles this figure, then the radio modulator does not have enough low-frequency coupling. Increasing the value of the coupling capacitor may help. Despite the different appearances of Figures 1 and 2, the same filter, excited by the same binary pattern, generated both.

Figure 3. Whereas Figure 1's waveform represents nearly perfect low-frequency response, this waveform is more realistic. It shows a low-frequency response coupled to about 0.5Hz. Although this response is adequate for DCS operation, the waveform droop is clearly visible.

from the digital codeword. Simply put, the long strings of ones and zeros in the digital codeword have been lost in the waveform's *droop.*

Low-frequency response

Figure 1's waveform represents nearly perfect low-frequency response. Figure 3's waveform (at the left) is more realistic. It shows a low-frequency response coupled to about 0.5Hz. Although this response is adequate for DCS operation, the waveform droop is clearly visible.

When the radio PTT is released, the transmitter should remain keyed for about 180ms. During this brief interval, a 134Hz tone that serves as a turn-off code is transmitted. Make sure the FM deviations of the turn-off code and the transmitted DCS codeword are not significantly different. Sometimes, if the encoder is being upset by the transmitter's RF field, the turn-off code is distorted.

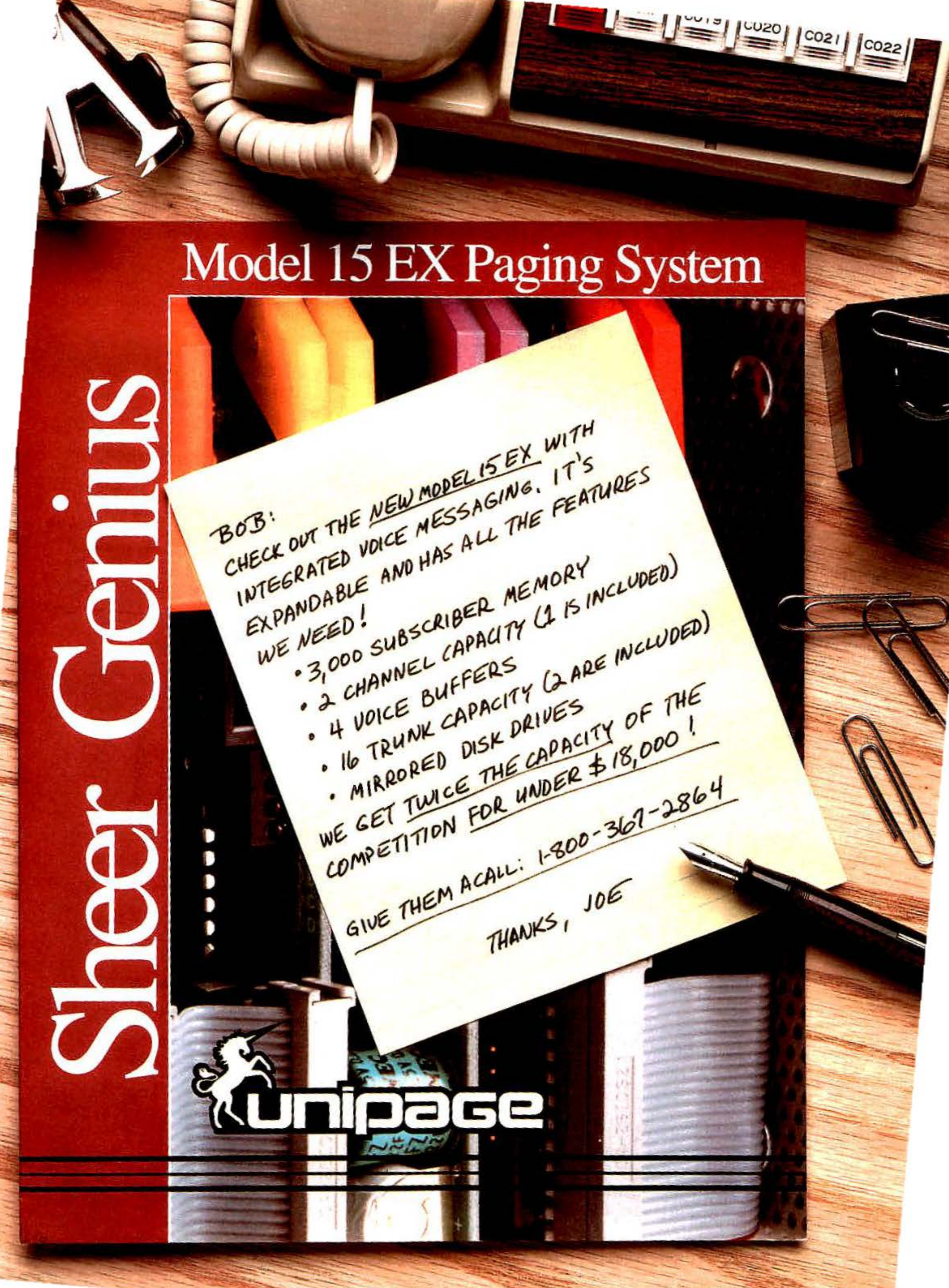
When keying the transmitter, make sure the DCS code appears quickly and the modulation symmetrically deviates about the carrier frequency. Because of dc transients, some transmitters slowly drift onto frequency when keyed. These effects must be eliminated because any perturbation of the transmitted DCS signal slows down the decoding process in the receiving radio.

Finally, make sure the radio operates properly with the antenna attached. This verification is particularly critical with portable transceivers. Many radios work fine into a 50Ω dummy load but not in the presence of their own RF fields. This effect is called RF desensitization or RF desense. Test the radio with a flexible, helically loaded portable antenna, flexing the antenna while observing the transmitted DCS signal on the service monitor.

Decoding

With a DCS test set attached to the service monitor, key the radio transmitter and measure the time the decoder takes to detect the DCS codeword. Using the radio PTT to trigger a storage oscilloscope, repeat this test 20 to 30 times.

Under these strong-signal conditions, the transmitted DCS signal should be decoded in less than 200ms, and the decode time should not vary by more than



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30ms. Variations of 50ms to 70ms or unusually long decode times may indicate some of the transmitted DCS codeword's leading bits are being chopped off. In performing this test, make sure the transmitter is tuned *exactly* to the proper operating frequency.

While performing the test described above, make sure the turn-off code the transmitter sends when the PTT is released closes the decoder attached to the service monitor within 180ms. When testing with another radio, if you hear a short noise burst called a squelch tail shortly after releasing radio PTT, then the turn-off code has been lost. Under strong-signal conditions, even occasionally missing the turn-off code may indicate a problem.

DCS series

Part 1, "Digitally Coded Squelch: What Makes It Work—Or Fail" appears in the November 1990 issue.

Part 2, "Digitally Coded Squelch: Filtering and Decoding" appears in the April 1991 issue.

Part 3, "Digitally Coded Squelch: Radio/Board Compatibility" appears in the January 1992 issue.

This article concludes the series.

Back issues of the past two years are available from Intertec Publishing for $5 each, postpaid. Telephone 913-541-6628.

Decoder evaluation

Testing a DCS decoder is much more complicated and time-consuming than testing the encoder.

Besides some subjective judgments as to what constitutes adequate performance, variations among receivers of the same radio model can affect test results. These variations are especially troublesome with receiver models that have a large unit-to-unit variation in the recovered audio level as measured at the discriminator output.

If possible, measure enough radios to determine reliably how much the discriminator output amplitude varies. To compile this information, apply the same RF test signal to a multitude of transceivers. From these measurements, select three radios, one at each extreme (minimum and maximum) and one that represents an average recovered audio level. Use the average case radio to make the following tests. Then repeat the tests with the remaining two radios. You may be surprised.

Event counter

After carefully reviewing and following the DCS vendor's installation instructions, make sure the decoder is functional. Next, tune the radio to an unused channel, attach an event counter to the decoder, and let it sit for a day. The event counter will accumulate the number of noise-falses the decoder experiences. A chart recorder used in place of the event counter would reveal the distribution of noise-falsing, too. If there is any doubt about the selected

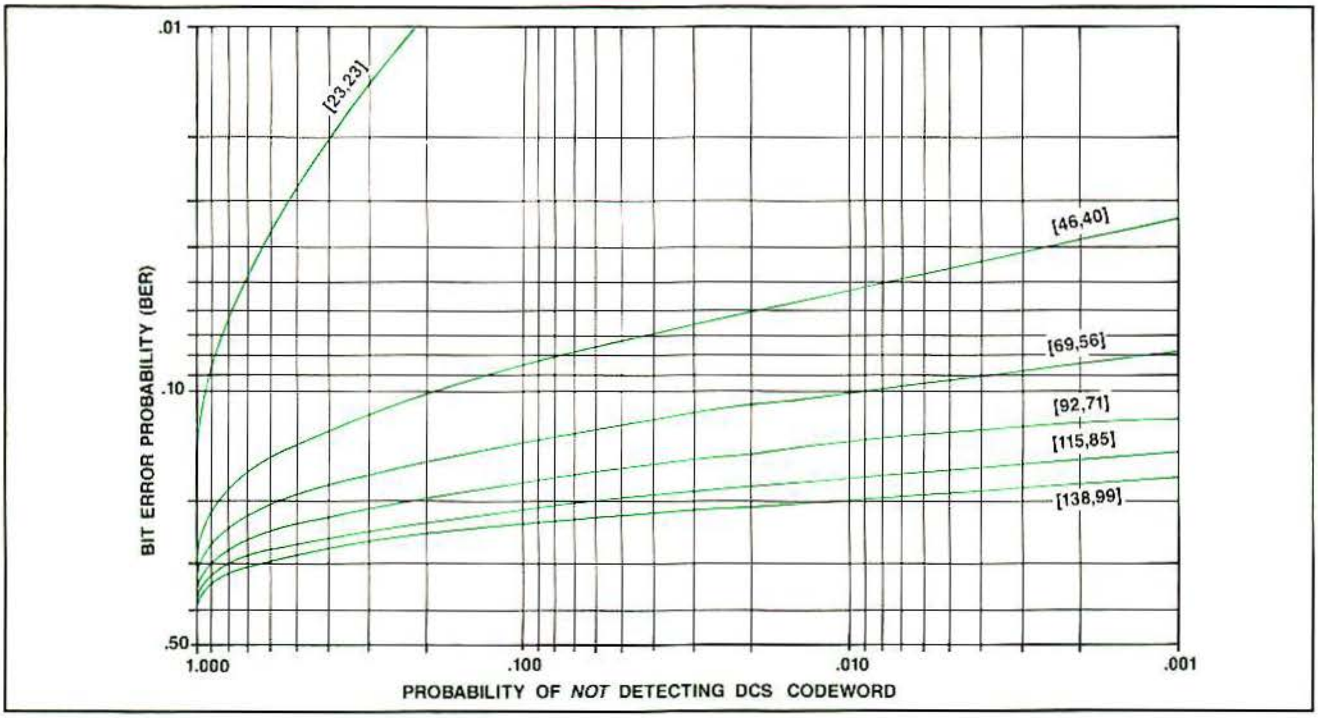


Figure 4. As discussed in Part 3 of this series, this computer-drawn graph shows the relationship between the bit-error rate (BER) and the probability of missing the DCS codeword for acceptable noise-falsing rates. The label [x,y] on each curve represents the sampling rate, a multiple of 23 bits, and the number of bits required for each correlation.

channel being vacant, use a blank channel or remove the radio channel element.

It is likely that each DCS decoder tested will perform differently in this test. But warning signs include decoders that false frequently (once every two-to-three hours or less) and those that do not false at all in 12 to 18 hours. Although this judgment is subjective, a compatible decoder typically noise-falses once every seven-to-12 hours.

These warning signs indicate *possible* incompatibility between a given decoder and a given radio. Do not infer these warning signs to mean the decoder is *poorly designed* because such a judgment would be rash and premature.

For instance, a DCS decoder that noise-falses frequently may need some simple adjustments. Conversely, a DCS decoder that rarely noise-falses may be well designed or may have degraded sensitivity, as the previous discussion of Figure 4 on page 25 (Figure 1 in Part 3) points out. Do not draw unwarranted conclusions at this stage of the testing procedure.

Furthermore, the word *compatible* has a subjective connotation. For those technicians whose evaluation criteria permit additional investigation or radio modifications that they engineer personally, the term *compatible* has a broad meaning. Similarly, for those technicians who adopt the position that the initiative belongs entirely with the DCS vendor to specify how to integrate their products into popular radios, the term has a narrower meaning.

It is likely, though, that DCS decoders that noise-false frequently also exhibit other unacceptable characteristics. Therefore, it is best to determine why the DCS decoder performs poorly, make the proper modifications to fix it or judge the DCS decoder to be incompatible with the application at hand. These are value judgments.

Next, check the DCS decoder's threshold sensitivity by applying an RF signal modulated with the proper DCS code to the receiver under test. Making sure the radio's noise squelch is fully open, increase the RF signal until the decoder unsquelches the radio without excessive chattering. The RF signal level should be less than that required to produce 6dB SINAD in the receiver.

When you flip the switch on the DCS encoder attached to the service monitor to the OFF position, the test set generates DCS turn-off code (TOC). The receiver under test should detect the TOC and squelch the radio within 180ms, although the TOC may be missed occasionally under these marginal conditions.

If the decoder consistently misses the TOC, increase the RF signal level until the decoder functions properly. A large difference between the threshold sensitivity and the TOC sensitivity indicates a poorly designed TOC detector.

Decoder attack time

All DCS decoders require time, called the *decoder attack time*, to detect an incident DCS codeword. Recalling that the cyclic DCS code starts at bit one, measurement of this characteristic

requires a trigger signal from the DCS test set attached to the service monitor. A simple trigger can be obtained from the switch on the test set. To properly measure the decoder attack time, the DCS decoder under test must receive the DCS codeword beginning at bit one.

To the experienced DCS technician, the DCS decoder attack time can be the one test that indicates how well the decoder works in the target receiver. The test has optimum diagnostic value when performed in two parts.

The first part, referred to as *strong signal attack time,* is a brute force functional test of the DCS decoder. A DCS system that performs poorly in this test has one of two problems. Either the DCS decoder design is faulty, or there is a major interface problem between the DCS decoder and the target receiver.

Test procedure

To perform this test, first apply a strong RF signal to the receiver being tested. This signal should be of sufficient amplitude to completely quiet the radio. The RF signal is continuous; only the DCS code that modulates the carrier is switched on and off.

Using the test set to trigger a storage scope, measure the decoder's attack time. Repeat the test 20 to 30 times while recording the results. The attack time should be less than 200ms and should not vary by more than 30ms under these ideal conditions.

Remember that the TOC detector is an integral part of the decoder design, and it requires evaluation.

Adjust the trigger level to make the storage scope trigger when the DCS test set is switched ON and when it is switched OFF. Measure the time it takes the decoder to detect the turn-off code sent by the test set. If it takes more than 180ms, the turn-off code has been missed. Remember that the TOC detector is an integral part of the decoder design, and it requires evaluation. As with the attack time, the TOC detect time should be constant, and the TOC never should be missed under these optimal conditions.

The second half of this two-part attack-time test resembles the first, except for slightly different test conditions.

Second part

Insert a coaxial relay between the service monitor and receiver, and adjust the monitor's RF output to minimum. Then slowly increase the RF level until the attack time, as described above, becomes relatively constant.

The object of this adjustment is to raise the RF signal level higher than the DCS threshold sensitivity, but only to a point where the decoder's attack time becomes relatively uniform in a noisy environment.

Because the noise contributes randomly to the decoding process, it is normal for attack time to vary. Typically, when the attack time becomes uniform to within 60ms to 85ms on average, the proper RF level has been reached. This RF level should be within 1.5dB of the threshold sensitivity.

Recalling the earlier discussion about providing a trigger signal from the test set that generates the DCS code, the same trigger must be used to open and close the RF relay. This is best accomplished by building a small timer circuit that, when activated, first closes the coaxial relay and then, 20ms-to-25ms later, activates the DCS test set. This sequence compensates for the relay closure time and permits a short *front porch* delay before enabling the DCS test set encoder.

Therefore, in this test, both the DCS modulation *and* the RF signal are applied to the test DCS receiver (at about the same time) to measure the decoder's attack time. Because the coaxial relay is open prior to applying the signal, the decoder is completely immersed in noise before the RF signal is applied.

Precise tuning

For reasons that will become apparent, it is extremely important that the signal generator be tuned to *exactly* the same frequency as the receiver. As before, the test is performed repeatedly.

Essentially, this test checks the compatibility of the interface between the DCS decoder and target receiver. Large increases in decoder attack time indicate something is wrong with this interface, and that the decoder is being affected adversely by the noise that preceded RF signal application.

If this is the case, assuming that the decoder performed adequately for the first part of the test, then chances are good that some investigation and modification may fix the problem. The exact remedy depends upon the DCS decoder design, but a good starting point would be to attenuate the discriminator output seen by the DCS decoder. If the attack times increase by less than 85ms (average), then the interface probably is adequate.

Radio environment

In actual operation, a DCS decoder must endure the anomalies that the radio environment thrusts upon it. For example, a radio receiver is rarely tuned exactly to the same frequency as the transmitter operating on that channel. The frequency-determining elements in both components have a *frequency stability* usually specified in parts per million (ppm). The frequency stability indicates how far the *tuned* frequency of each device drifts from the ideal.

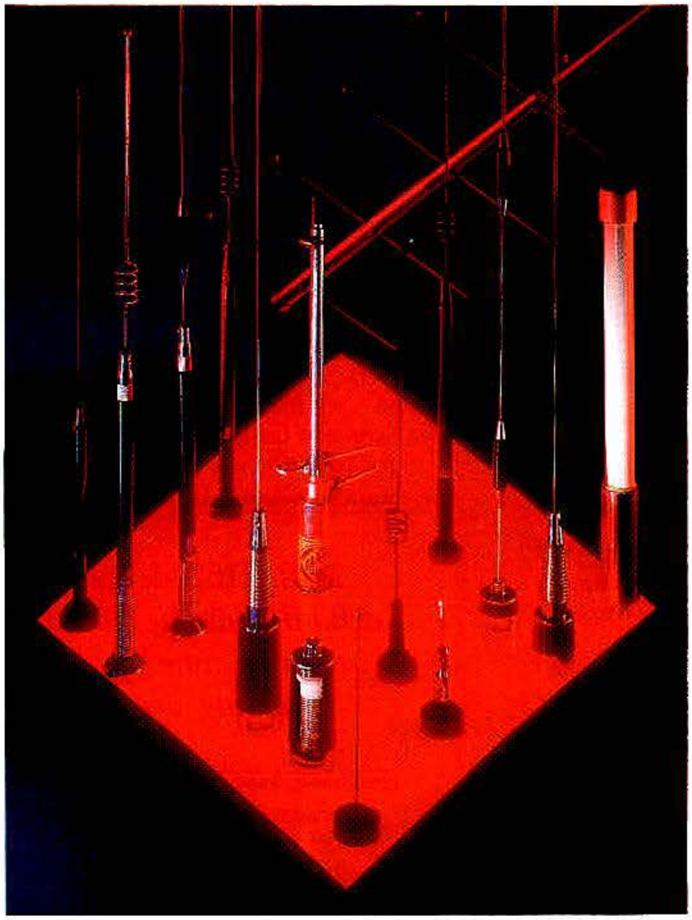
For a typical UHF base station, the frequency stability is ±2ppm; for a typical portable radio, ±5ppm. Because each radio's frequency drifts independently, the net frequency error *seen by the receiver* could be ±7ppm for repeater operation and ±10ppm for simplex operation. The additive nature of frequency drift is called *netting error*.

...a DCS decoder must endure the anomalies that the radio environment thrusts upon it.

Unfortunately, netting error shows up at the discriminator output as a *step* function. Because of the long time constants required for the low-frequency response, a step function can block the decoder momentarily.

Netting error test

This brings up the topic no DCS vendor wants to talk about, including the OEM radio vendors—the dreaded netting error test. It probably is the toughest problem to overcome in a universal decoder because of the large variety of radios in which the decoder is expected to function. Even some OEM radios have difficulty controlling this characteristic because of unit-to-unit variations in the same radio model. About the only



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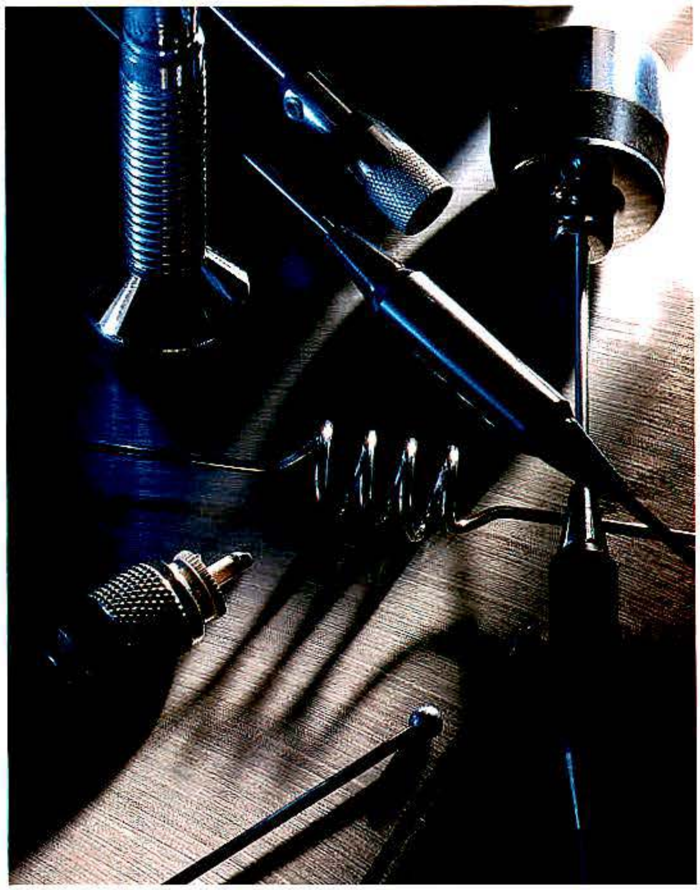

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nice thing about netting error is that it is easy to measure.

Using the attack-time measuring setup previously described, apply enough signal to quiet the radio fully when the coaxial relay is closed, but not enough to *spray* across the relay when it is open. The DCS decoder must be immersed in noise when the coaxial relay is open.

Offset the service monitor's frequency to correspond to the maximum netting error on the low side of the RF carrier frequency. Next, measure the decoder attack time. Repeat this procedure, offsetting the RF carrier in 500Hz steps until the most positive frequency is reached. Graph the results with frequency offset on the horizontal axis and the attack time on the vertical axis. Do not assume the curves will be symmetrical on either side of the nominal carrier frequency. Now you know why no one likes to talk about netting error.

Most DCS decoders exhibit some degradation in attack time for large netting errors. But drastic increases in attack time are unacceptable. Unless you are prepared to retune your radio fleet frequently to keep the DCS decoder and its user happy, carefully evaluate and scrutinize the DCS decoder's netting error performance.

Most DCS decoders exhibit some degradation in attack time for large netting errors.

Depending upon the DCS decoder design, it may be possible to adjust or modify the device to better tune it to your application.

Optimizing netting error

Unfortunately, optimizing the netting error performance usually involves customizing both the decoder design and the radio interface. Here the OEM radio vendor can tailor its DCS decoder's design to the radio, but most board-level DCS vendors do not want to discuss the possibility. Although it is feasible for the board-level DCS vendor to provide the means to customize their products, such an optimization could require adjustable components. Besides requiring the user to make the adjustments, adjustable components complicate decoder design, make it harder to miniaturize and increase the cost.

For radios using digital squelch, the audio bandwidth is partitioned into two bands. A subaudible band is used for DCS signaling, and an audible band is used for concurrent voice communication. At the boundary between these two bands, the DCS decoder can be blocked by high-amplitude signals in the voice band. The DCS decoder low-pass filter's design figures prominently in this test because it controls the amount of voiceband rejection.

Measuring DCS decoder blocking is

Continued on page 105

Measuring duplex curves in your own shop

Part 2—Make sure your duplex system is based on real *transceiver characteristics, not someone else's worst-case assumptions. The result can reduce duplexer or multicoupling equipment costs significantly.*

By Ernesto A. Alcivar

Part 1 in last month's issue took you through steps that laid the groundwork for duplex curve measurements. This concluding installment covers the test procedure by measuring TN-RD curves.

Alcivar has 19 years of practical experience in radio communications systems.

Also known as "TN-RD" curves (for *T*ransmitter *N*oise-*R*eceiver *D*esensitization), duplex operation curves specify the minimum RF isolation required between a given transmitter-receiver pair as a function of T-R spacing to limit desensitization to a specified maximum. A 1dB reduction of SINAD is the most common standard.

Figure 1 below shows a set of duplex operation curves for a duplex pair consisting of two low-cost VHF mobile transceivers. The curves result from measurements made using equipment and techniques previously described. The curves represent the poor performance that can be expected when low-cost mobile radios are used in duplex service or co-located transceiver installations.

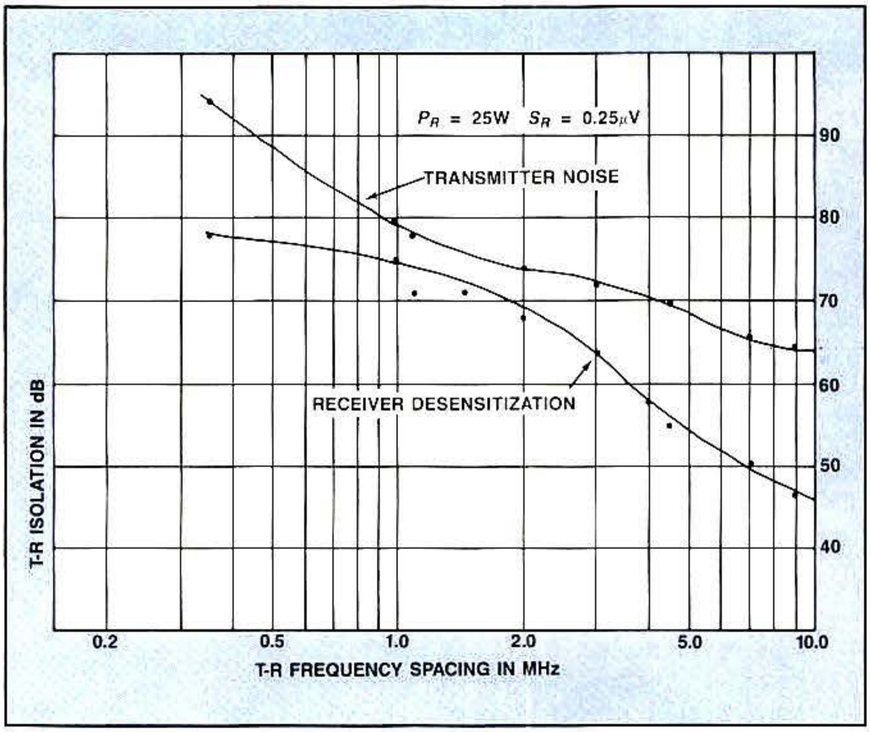


Figure 1. Duplex operation curves for a duplex pair consisting of two low-cost VHF mobile transceivers. The curves result from measurements made by using equipment and techniques described in Part 1. The curves represent the poor performance that can be expected when low-cost mobile radios are used in duplex service or co-located transceiver installations.

The curve labeled receiver desensitization specifies the minimum isolation required at the transmit frequency to limit desensitization by the transmitter carrier to a 1dB reduction of SINAD.

The curve labeled transmitter noise specifies the minimum T-R isolation required at the receive frequency to limit desensitization by transmitter broadband noise to a 1dB reduction of SINAD.

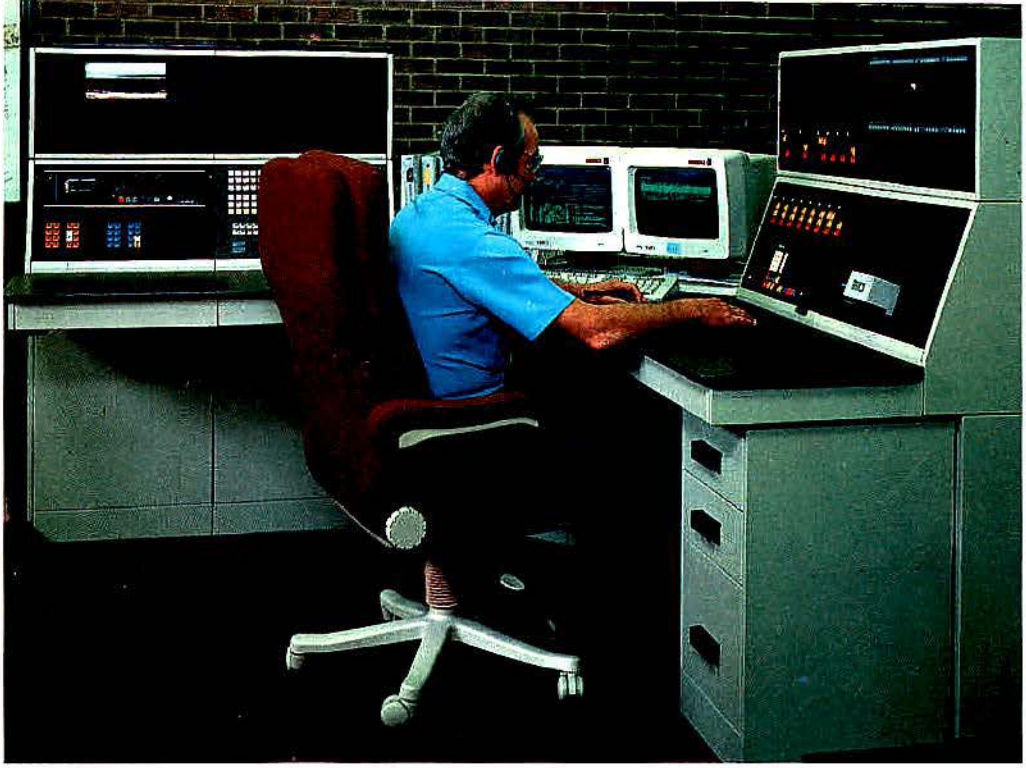
To facilitate their application, duplex operation curves usually are normalized to 25W or 100W transmitter power and 0.25μV receiver sensitivity. Correction factors for other receiver sensitivities and transmitter powers can be computed easily.

Test setup, duplex measurements

Figure 2 on page 36 shows a practical test setup to obtain duplex operation data for any transmitter-receiver pair. It resembles the Figure 3 setup in Part 1, with the addition of a wattmeter to measure transmitter power and a resonant cavity filter to ensure that receiver desensitization is caused either by transmitter carrier or broadband noise.

The interfering signal, which is a filtered sample of the transmitter output, enters the receiver via the in-line RF coupler. The sample is obtained through a 30dB power attenuator in series with a resonant cavity filter that enhances one interfering signal component (carrier or noise) and suppresses the other.

When every second counts...



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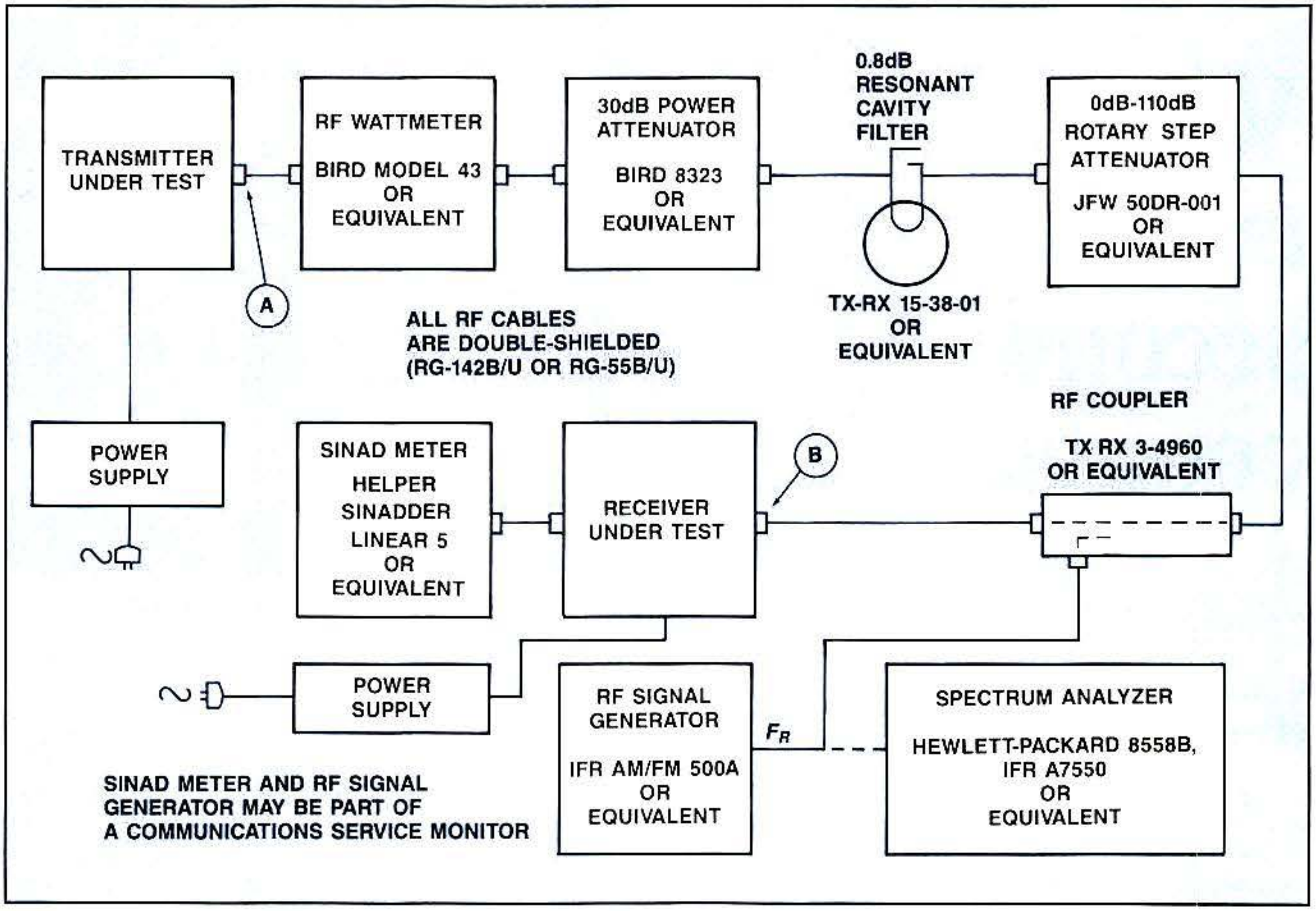

Figure 2. This practical test setup obtains duplex operation data for any transmitter-receiver pair. It resembles the Figure 3 setup from Part 1, with the addition of a wattmeter to measure transmitter power and a resonant cavity filter to ensure that receiver desensitization is caused either by transmitter carrier or broadband noise.

To obtain data for the receiver desensitization (RD) curve, which depends on desensitization by the carrier, tune the cavity filter to pass the transmitter frequency and reject the receiver frequency. To obtain data for the transmitter noise (TN) curve, which depends on desensitization by transmitter noise, tune the filter to pass the receiver frequency and reject the transmitter frequency.

To obtain satisfactory TN-RD data, use a cavity filter with no less than 30dB of unwanted signal suppression at minimum T-R frequency spacing. Using a 4-inch diameter pseudo-bandpass cavity filter with loops set to 0.8dB insertion loss, VHF highband data down to 0.355MHz spacing was obtained. Purists will advocate using a high-selectivity bandpass filter instead. Never mind. Use whatever is conveniently available, especially if it is a component of your favorite duplexer.

Table 1 at the right lists the filter response at T-R frequency spacings of 0.2MHz to 1.4MHz. The data column labeled SUPP is the minimum suppression provided in a bandwidth of 50kHz around the unwanted frequency. If you need data at close T-R spacings, use two or three cavity filters in series.

The step attenuator on the output side of the cavity filter adjusts total T-R attenuation to produce the prescribed 1dB reduction of receiver SINAD.

The spectrum analyzer is used as a selective level meter to tune the cavity filter and measure signal levels and insertion losses. An RF millivoltmeter with a 50Ω probe can be used as an alternative.

Make sure that the transmitter and receiver are shielded and isolated from one another so that receiver desensitization results only from interfering signals transmitted through the test path. Use double-shielded coaxial cables (RG-142B/U or RG55B/U).

Table 1—Response data for the Tx-Rx Systems model 15-38-01 Vari-Notch 4-inch-diameter quarterwave, 0.8dB-loss cavity filter (T-R spacing from 160.000MHz).

T-R (MHz)	LOSS (dB)	SUPP (dB)
0.2	− 0.8	N/A
0.4	−31.0	−27.0
0.6	−37.0	−33.0
0.8	−42.0	−38.0
1.0	−45.0	−41.0
1.2	−47.0	−43.0
1.4	−48.0	−45.0

Receiver front-end, oscillator and mixer tuning have a profound effect on RD measurements, so tune the receiver to a fixed frequency carefully. Change the transmitter frequency only to attain different T-R spacings.

You may obtain different TN and RD measurements at the same T-R spacing,

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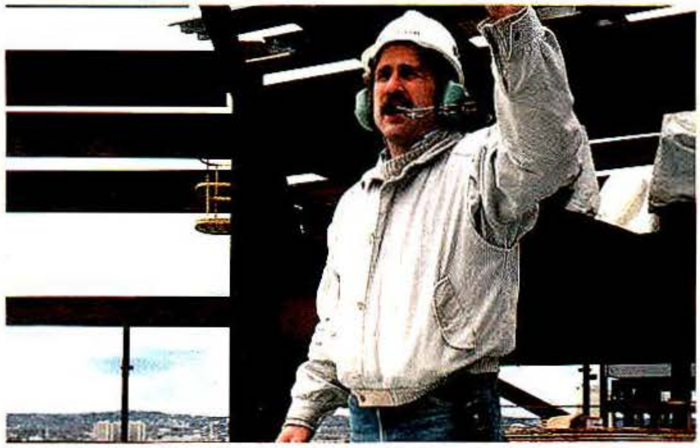

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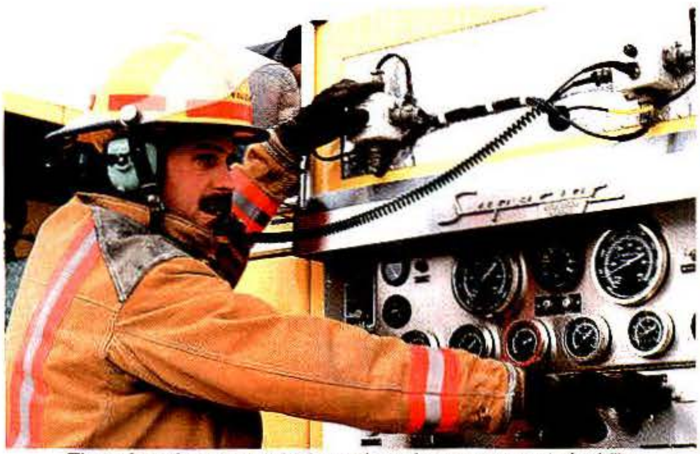

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Table 2—An example of measured data and a spreadsheet format that facilitate data recording and reduction.

MEASURED DUPLEX OPERATION DATA (TN FOR 1 dB SINAD REDUCTION)

Transmitter: VHF Transceiver "A", Serial No. DS211
Receiver: VHF Transceiver "A", Serial No. DS212

Ft(MHz)	Fr(MHz)	dF(MHz)	Lo (dB)	La (dB)	Pt(W)	Sr(uV)	Lt(dB)	Sr/S (dB)	P/Pt (dB)	TN(dB)
161.625	151.615	10.010	32.0	35.0	31.0	0.20	67.0	-1.9	-0.9	64.2
160.625	151.615	9.010	32.0	35.0	30.0	0.20	67.0	-1.9	-0.8	64.3
159.000	151.615	7.385	32.0	36.0	32.0	0.20	68.0	-1.9	-1.1	65.0
158.625	151.615	7.010	32.0	37.0	34.0	0.20	69.0	-1.9	-1.3	65.8
156.625	151.615	5.010	32.0	40.0	36.0	0.20	72.0	-1.9	-1.6	68.5
156.125	151.615	4.510	32.0	41.0	35.0	0.20	73.0	-1.9	-1.5	69.6
154.625	151.615	3.010	32.0	43.0	33.0	0.20	75.0	-1.9	-1.2	71.9
153.625	151.615	2.010	32.0	45.0	34.0	0.20	77.0	-1.9	-1.3	73.8
152.800	151.615	1.185	32.0	49.0	34.0	0.20	81.0	-1.9	-1.3	77.8
152.600	151.615	0.985	32.0	51.0	34.0	0.20	83.0	-1.9	-1.3	79.8
151.970	151.615	0.355	32.0	65.0	33.0	0.20	97.0	-1.9	-1.2	93.9

Sr/S (dB) = 20*log(Sr/0.25)
P/Pt (dB) = 10*log(25.0/Pt)

depending on whether the transmit frequency is above or below the receive frequency. In this case, use the larger of the two measurements at each frequency spacing.

Table 2 above and Table 3 on page 40 show a set of measured data and a spreadsheet format that facilitate data recording and reduction.

► Use the following procedure to obtain data for the transmitter noise (TN) curve:

(1) Measure receiver sensitivity S in μV at point B.

(2) Tune the cavity filter to pass the RECEIVE frequency and reject the transmit frequency. Set the step attenuator to 0dB. Measure insertion loss L_o in dB at the RECEIVE frequency between point A and point B.

(3) With the transmitter off, set the signal generator to produce exactly 12dB SINAD at the receiver output.

(4) Key the transmitter. Record transmitter power P in watts.

(5) Adjust the step attenuator until receiver SINAD decreases to exactly 11dB. Record attenuator setting L_a in dB. Unkey the transmitter.

(6) The total required attenuation at the receive frequency (TN), referenced to P_r watts transmitter power and receiver sensitivity S_r μV, is:

$$\text{TN (dB)} = L_o + L_a + 10\log(P_r/P) + 20\log(S/S_r)$$

(7) Change the transmit frequency and retune the transmitter.

(8) Retune the cavity filter to reject

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Table 3—An example of measured data and a spreadsheet format that facilitate data recording and reduction.

MEASURED DUPLEX OPERATION DATA (RD FOR 1 dB REDUCTION OF SINAD)

Transmitter: VHF Transceiver "A", Serial No. DS211
Receiver: VHF Transceiver "A", Serial No. DS212

Ft(MHz)	Fr(MHz)	dF(MHz)	Lo (dB)	La (dB)	Pt(W)	Sr(uV)	Lt(dB)	Sr/S (dB)	P/Pt (dB)	RD(dB)
161.625	151.615	10.010	32.0	17.0	31.0	0.20	49.0	-1.9	-0.9	46.2
160.625	151.615	9.010	32.0	17.0	29.0	0.20	49.0	-1.9	-0.6	46.5
158.625	151.615	7.010	32.0	21.0	30.0	0.20	53.0	-1.9	-0.8	50.3
156.125	151.615	4.510	32.0	26.0	33.0	0.20	58.0	-1.9	-1.2	54.9
155.625	151.615	4.010	32.0	29.0	34.0	0.20	61.0	-1.9	-1.3	57.8
154.625	151.615	3.010	32.0	35.0	34.0	0.20	67.0	-1.9	-1.3	63.8
153.625	151.615	2.010	32.0	39.0	33.0	0.20	71.0	-1.9	-1.2	67.9
153.035	151.615	1.420	32.0	42.0	33.0	0.20	74.0	-1.9	-1.2	70.9
152.800	151.615	1.185	32.0	42.0	33.0	0.20	74.0	-1.9	-1.2	70.9
152.600	151.615	0.985	32.0	46.0	33.0	0.20	78.0	-1.9	-1.2	74.9
151.970	151.615	0.355	32.0	49.0	34.0	0.20	81.0	-1.9	-1.3	77.8

Sr/S (dB) = 20*log(Sr/0.25)
P/Pt (dB) = 10*log(25.0/Pt)

the new transmit frequency. Do not change the cavity pass (receive) frequency.

(9) Repeat steps 3 to 8 at all T-R spacings of interest.

► Use the following procedure to obtain data for the receiver desensitization (RD) curve:

(1) Measure receiver sensitivity S in μV at point B.

(2) Tune the cavity filter to pass the TRANSMIT frequency and reject the receive frequency. Measure insertion loss L_o in dB at the TRANSMIT frequency between point A and point B.

(3), (4), (5) Same as above.

(6) The total required attenuation at the transmit frequency (RD), referenced to P_r watts transmitter power and S_r μV receiver sensitivity, is:

$$\text{RD (dB)}$$

$$= L_o + L_a + 10\log(P_r/P) + 20\log(S/S_r)$$

(7) Change the transmitter frequency and retune the transmitter.

(8) Retune the cavity filter to pass the new transmitter frequency. Do not change the reject (receive) frequency.

(9) Repeat steps 3 to 8 at all T-R spacings of interest.

Plot the results on 2- or 3-cycle log paper, as shown in Figure 1. Use a flexible spline or French curve to produce smooth curves for your diagrams.

As with other RF specifications, you will find relatively large TN and RD measurement variations among transmitters and receivers of the same model and from the same production lot.

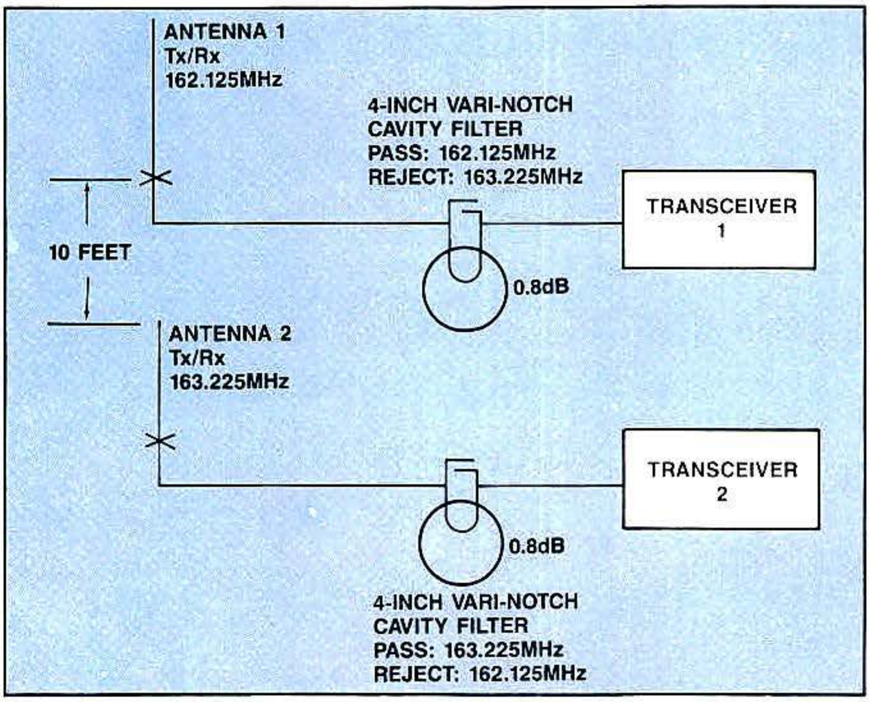

Figure 3. Table 1 shows that a typical bandpass/band-reject filter for duplex operation measurements provides approximately 46dB or isolation at 1.1MHz separation. An additional 34dB of space isolation is required to fulfill the 79.5dB requirement. This isolation is achieved easily with 10 feet of vertical spacing between antennas.

If you measure a number of transmitters and receivers to determine worst-case conditions, plot the curve through the largest TN and RD measurements at each frequency spacing. This provides a conservative margin for production variations.

If you measure only one transmitter and receiver, it is prudent to design your duplex system to operate with 6dB to 10dB more isolation than indicated by the your curves.

Curve applications

With a set of duplex operation curves on hand, it is easy to design duplex or multicoupled systems for minimum desensitization.

For example, consider an application in which two simplex transceivers of the type characterized by Figure 1 must be installed on the same site to operate on 162.125MHz and 163.225MHz. Measured transmitter power is 34W. Receiver sensitivity is 0.32μV.

T-R frequency spacing is 163.225MHz − 162.125MHz = 1.1MHz. On Figure 1, draw a vertical line at 1.1MHz frequency spacing to intersect the TN and RD curves. The curves show that 79dB TN (transmitter noise suppression at the receive frequency) and 74dB RD (transmitter noise suppression) are required.

The correction C_t for 34W transmitter power is:

$$C_t = 10\log(34/25) = +1.3\text{dB}$$

The correction C_r for 0.32μV receiver sensitivity is:

$$C_r = 20\log(0.25/0/32) = -0.8\text{dB}$$

A correction of 1.3dB − 0.8dB = +0.5dB is added to obtain TN and RD values of 79.5dB and 74.5dB. This is the minimum isolation that must be provided at the receiver and transmitter frequencies, respectively.

An examination of 160MHz antenna isolation curves shows that 100 feet of vertical separation provides about 65dB of isolation. This is far from the required 79.5dB and is quite expensive in terms of tower space. Even if unlimited tower space were available, desensitization-free operation of these transceivers may not be possible even

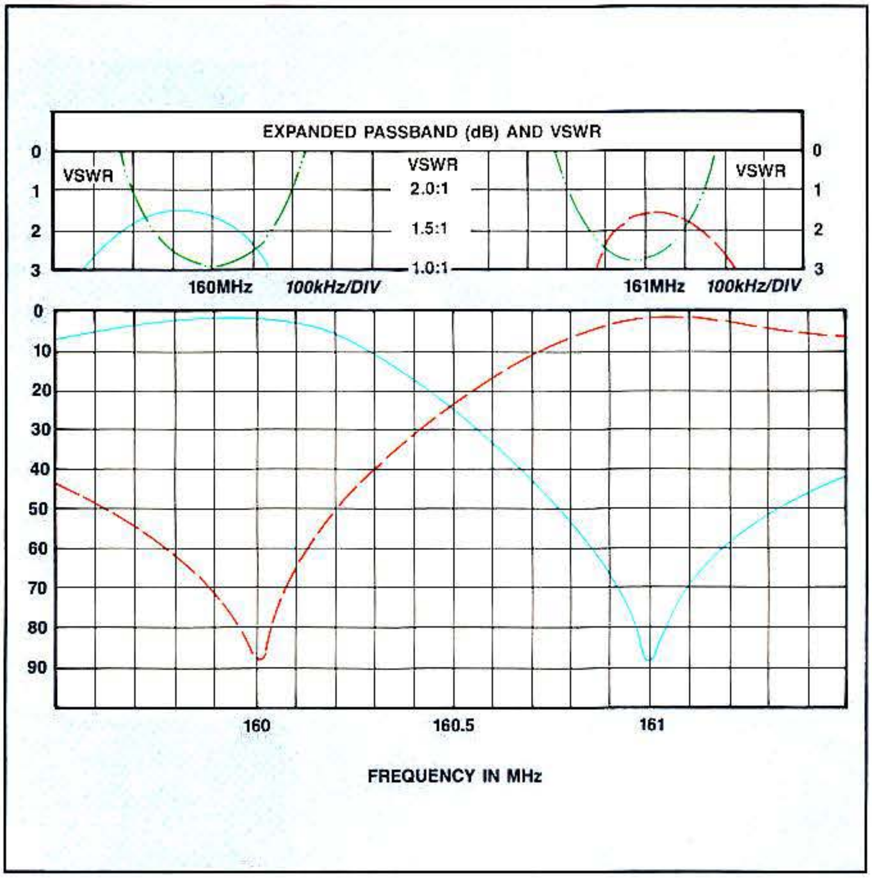

Figure 4. A superior alternative to the 10-foot spacing shown in Figure 3 is to use a duplexer to couple both transceivers to a single antenna. These are the response curves of a pseudo-bandpass duplexer suitable for this application. They show that more than 86dB of isolation can be attained between transceivers at a T-R spacing of 1.1MHz. Additionally, the duplexer provides more than 50dB of broadband isolation between transceivers, which is, from the viewpoint of the receiver, the equivalent of improving transmitter spurious rejection specifications by 50dB. This alternative avoids the cost of materials and installation of a second antenna and feedline and provides superior isolation for desensitization-free operation.

with 100 feet of vertical antenna spacing. Moreover, the large difference in antenna heights would give one transceiver much greater range than the other. Therefore, other alternatives must be considered.

The first alternative is to use a combination of separate antennas and resonant cavity filters to attain the desired isolation.

Table 1 shows that a bandpass/band-reject filter of the type used for duplex operation measurements would provide approximately 46dB or isolation at 1.1MHz separation. An additional 34dB of space isolation would be required to fulfill the 79.5dB requirement. This isolation is achieved easily with 10 feet of vertical spacing between antennas. Figure 3 on page 42 shows the resulting arrangement.

The second alternative is to use a duplexer to couple both transceivers to a single antenna. Figure 4 above shows response curves of a pseudo-bandpass duplexer that is suitable for this application. The curves show that more than 86dB of isolation can be attained between transceivers at a T-R spacing of 1.1MHz. Additionally, the duplexer provides more than 50dB of broadband isolation between transceivers, which is, from the viewpoint of the receiver, the equivalent of improving transmitter spurious rejection specifications by 50dB.

The second alternative is by far the best: It avoids the cost of materials and installation of a second antenna and feedline, and it provides superior isolation for desensitization-free operation.

Final word

Do you really have to measure data for curves over a wide range of T-R frequency separations?

Of course not. You may wish only to measure TN-RD at separations of, say, 500kHz, 1MHz and 5MHz for your preferred VHF highband equipment. Or you may choose to measure TN-RD only at the actual operating frequencies of the transmitters and transmitters you are about to install in a new system. If you use the same radios all the time, though, it certainly would be worthwhile to obtain curves for them.

What are the benefits of making your own duplex operation measurements?

First, you gain the certainty that your duplex system designs and installations are based on the *real* characteristics of your radios, not someone else's worst-case assumptions. This fact alone may translate into significant reductions in the cost of duplexers or multicoupling equipment.

Conversely, you may find that inexpensive radios require lots of expensive RF isolation and are not really appropriate for duplex or co-located service. In this case, the use of better-grade radios may not significantly increase system cost, but may increase long-term user satisfaction.

Second, an improvement of just a few decibels in receiver sensitivity can increase mobile-to-base and portable-to-base ranges significantly, thus resulting in greater customer satisfaction. Such improvements often can be achieved at little cost, after the sources and extent of desensitization are determined.

Economy, reliable performance and greater customer satisfaction result with using these improvements.

References

1. "How To Use Duplex Operation Curves," General Electric Mobile Radio Department, Datafile Service Bulletin No. 100007-4, May 1972.
2. "Selectivity Data, Bandpass and T-Pass Filters," Tech-Aid No. 77003, TX-RX Systems.
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Selecting base antennas for cellular systems

Knowing the ins and outs of base antennas is essential for the cellular system engineer. Knowing a few myths perturbating the industry and how to avoid them may help you in your selection and installation.

By Andrew Singer and Paul Castrucci

Cellular base antennas often are arrays of halfwave radiators, one form of which is the dipole. The dipole is the basic transducer, accepting RF energy from a feedline and radiating it as an electromagnetic wave into the world. The basic dipole is a resonant device with 0dBd gain. Antenna engineers have found ways to increase antenna gain to improve system performance.

For an omnidirectional pattern, dipoles are stacked vertically to compress the vertical pattern into a doughnut shape similar to Figure 1 below. The vertical and horizontal patterns are shown in Figure 2 below.

Singer is senior applications engineer, and Castrucci is systems engineer at Sinclair Radio Labs, Tonawanda, NY.

These radiation patterns represent how well the antenna disperses energy into surrounding space. Gain results from a narrowing of the vertical beamwidth.

An omnidirectional antenna, by definition, has a circular pattern in the horizontal plane.

Doubling the number of dipoles in the array decreases its vertical beamwidth by approximately half and increases its gain by 3dB. Use this simple relationship to estimate gain based on beamwidth, and vice versa.

For example, a dipole (0dBd gain) has approximately 72° beamwidth. Thus, an omnidirectional antenna with 18° of vertical beamwidth (72° ÷ 2 ÷ 2) has approximately 6dBd gain (0dBd + 3dBd + 3dBd).

Another way to increase gain is to place a reflector behind the radiator to shape and focus the radio energy in the horizontal plane. Figure 3 on page 48 shows a horizontal pattern with a 90° beamwidth.

The only way to achieve gain is to control the radio energy that otherwise would go in all directions and to focus the energy in the desired direction, much the way your vehicle headlight focuses light toward the front. By sacrificing lighting toward the rear, the distance that usable light reaches toward the front is increased.

Gain myth

When reading gain specifications, look for two pieces of information.

Gain can be expressed in dBd or dBi. The dBd unit measures gain compared to a dipole, the antenna with the previ-

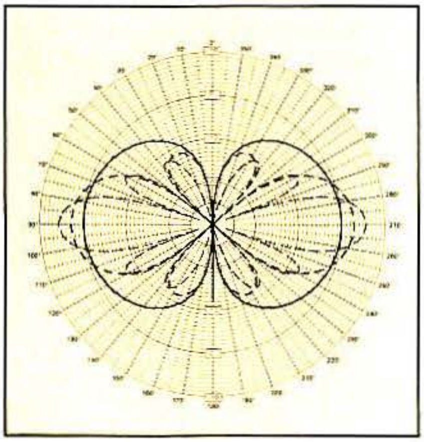

Figure 1. Stacked dipoles compress the vertical pattern. The solid line is the pattern of one dipole; the dashed line is the pattern of two stacked dipoles.

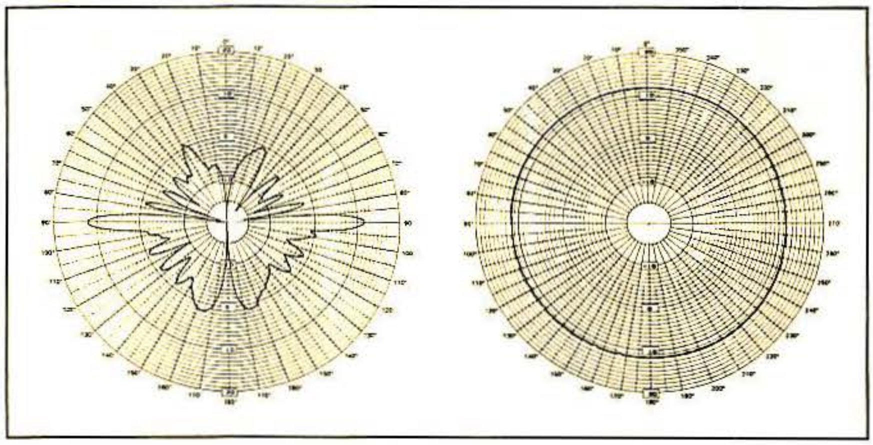

Figure 2. Vertical pattern for the two-stacked-dipoles array from Figure 1 appears to the left. Maximum energy appears along a line toward the horizon. The array's horizontal pattern appears on the right. The circular pattern represents omnidirectional coverage.

ously mentioned approximately 72° beamwidth. The dBi unit measures gain compared to an isotropic radiator, an imaginary antenna that radiates equally in all directions.

A dipole has 2.1dB gain compared to the isotropic radiator. Gain expressed in dBi always is 2.1dB higher than gain expressed in dBd. Most cellular base antenna manufacturers express gain in dBd. If the measurement unit is unclear, call the manufacturer to find out.

Moreover, do not be concerned about gain differences as little as 0.25dB. A typical antenna range can measure antenna gain only to within ±0.5dB. With the measurement accuracy limited to 0.5dB in most cases, why worry about a 0.25dB difference? After all, a difference of 1dB is barely discernible, so a 0.25dB difference is negligible.

Most cellular base antenna manufacturers express gain in dBd. If the measurement unit is unclear, call the manufacturer to find out.

Much is said about "null-fill," which is an antenna design characteristic intended to increase the amount of radio energy directed toward the ground, especially to areas near the antenna.

The narrow beam of energy from an especially high-gain antenna overshoots areas close to an antenna, particularly if it is mounted at a high elevation. The question is whether the signal is strong enough in the null to serve ground areas close to the antenna without taking special measures to increase it.

Figure 4 on page 48 shows the vertical pattern of an antenna with 18dBd gain and a vertical beamwidth of 4.5°, an extremely narrow beamwidth that serves to represent the worst case. Some system engineers might worry about the deep null at 99°. Figure 5 on page 50

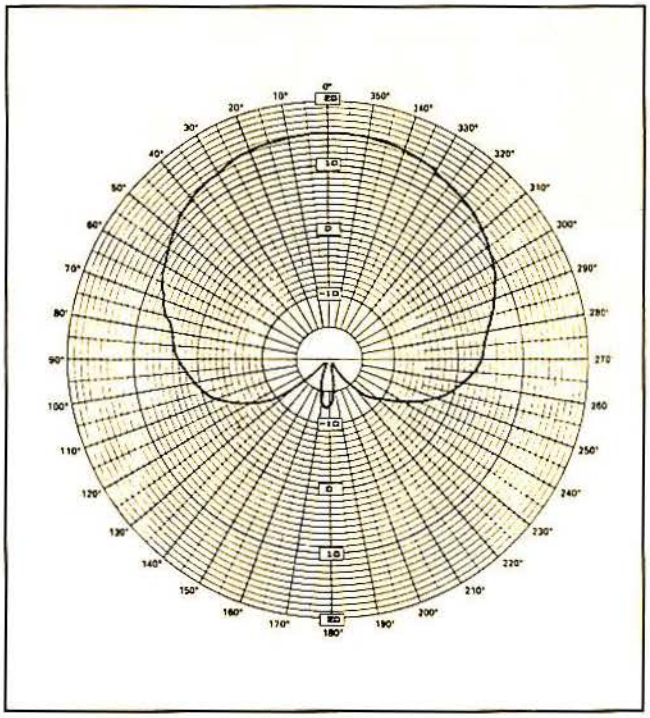

Figure 3. A reflector behind the radio shapes this antenna's horizontal pattern into a 90° beamwidth.

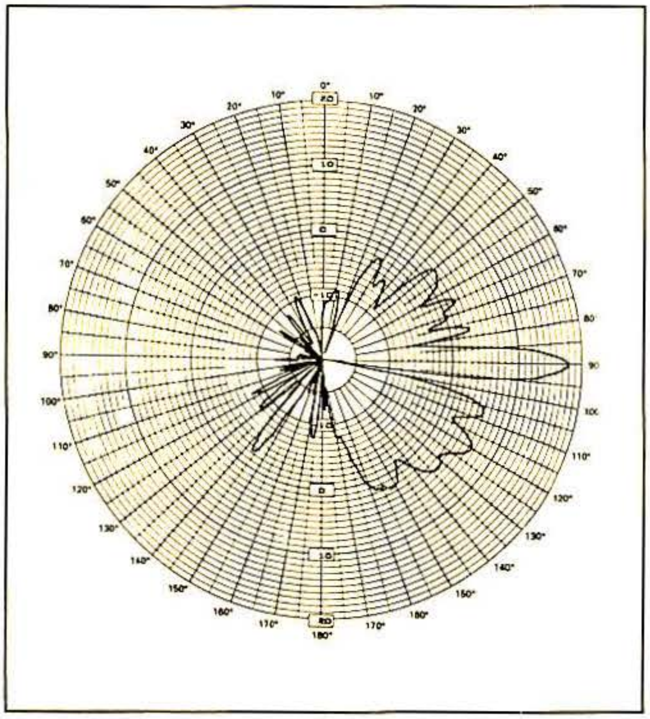

Figure 4. The vertical pattern of an antenna with 18dBd gain and a vertical beamwidth of 4.5° has an extremely narrow vertical beamwidth.

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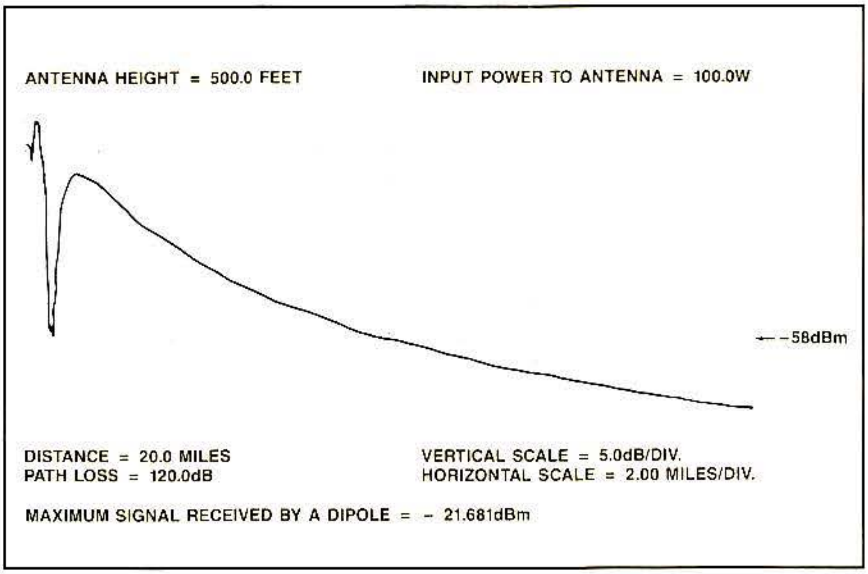

Figure 5. Some engineers might worry about the deep null at 99° produced by the antenna in Figure 4. This diagram shows that the signal level in the null 0.5 miles from the antenna is −58dBm, an excellent signal.

addresses that question.

The figure shows the signal level delivered in the null 0.5 miles along the ground from the antenna, which is mounted 500 feet high. The signal level is −58dBm, an excellent signal.

Several conditions that can cause the actual signal level to differ from the predicted level should be kept in mind.

First, the prediction is based on a model with smooth earth and good soil.

The signal could be weaker behind obstructions.

Second, the model has no obstructions that would block the signal and no objects that would reflect the signal. The signal could be weaker behind obstructions. In the presence of reflecting objects, the combination of multiple radio waves can add to and subtract from signal strength.

The result would be areas of higher and lower signal than what is shown in Figure 5. Is the predicted −58dBm signal strong enough for good coverage?


PATRIOT
1 2 3
4 5 6
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Field experience provides the useful answer.

Another point to consider is whether the null falls in an area where coverage is unimportant.

Simple trigonometry will define the ground area within the null. In most cases, this area is close to the site where less power is necessary to achieve good coverage.

Downtilt myth

Downtilt focuses the signal below the horizon. It is not the solution for all radio system problems. Figure 6 on page 54 shows how downtilt usually is illustrated, but Figure 7 on page 54 is a more accurate representation. Notice that coverage is provided to almost all the desired area by signal in the antenna's main lobe so downtilt is not often useful, except to reduce co-channel interference.

Most cellular systems use antennas at fairly low elevation, so downtilt is not often useful. For the sake of readers whose radio systems use extremely high antenna sites, such as a 10,000-foot mountain, the following formula can be used to calculate downtilt:

$$\text{Angle} = \text{inv tan } (H/D)$$

where

H = elevation of site over coverage point

D = distance from site to coverage area

With this formula, downtilt can be calculated to a given point. To calculate downtilt for an area instead of a point, the formula is:

$$D_{min} = \frac{\left(\frac{H}{\tan}\right)\left(\text{downtilt} + \frac{HPBW}{2}\right)}{5{,}280}$$

$$D_{max} = \frac{\left(\frac{H}{\tan}\right)\left(\text{downtilt} - \frac{HPBW}{2}\right)}{5{,}280}$$

D_{min} is where the half-power beamwidth intersects the ground nearest to the antenna. The half-power beamwidth is the angle at which the power in the signal lobe is 3dB less than the maximum power in the lobe.

D_{max} is where the half-power beamwidth intersects the ground farthest from the antenna.

This footprint, the area between D_{min} and D_{max}, is called the primary illumination area.

The distances are divided by 5,280 to convert the units to miles.

A copy of a computer program for calculating the primary illumination

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Continuous:	100 watts	200 watts	500 watts
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Output voltage:	115 VAC RMS ± 5%	115 VAC RMS ± 5%	115 VAC RMS ± 5%
Output frequency:	60 Hz ± 2%	60 Hz ± 0.01%	60 Hz ± 0.01%
Output waveform:	modified sinewave, phase corrected	modified sinewave, phase corrected	modified sinewave, phase corrected
Efficiency:	90%	90%	90%
Low battery alarm:	10.7 V	10.7 V	10.7 V
Low battery shutdown:	10 V	10 V	10 V
Dimensions (H x W x L):	1.2" x 3.5" x 4.5"	1.5" x 4.5" x 6"	3" x 9" x 10"
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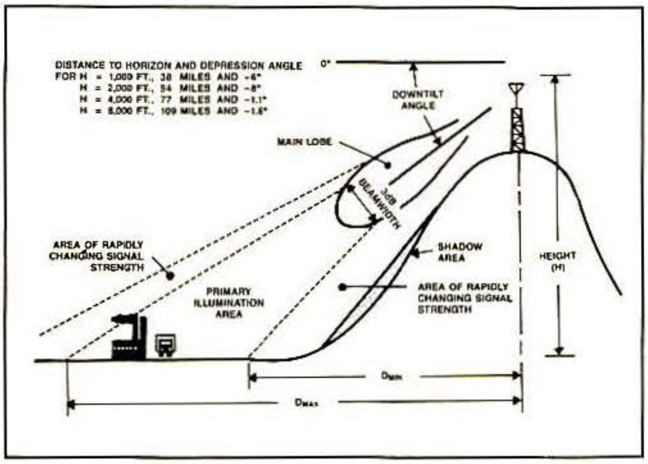

Figure 6. Downtilt focuses the signal below the horizon. It is not the solution for all radio system problems.

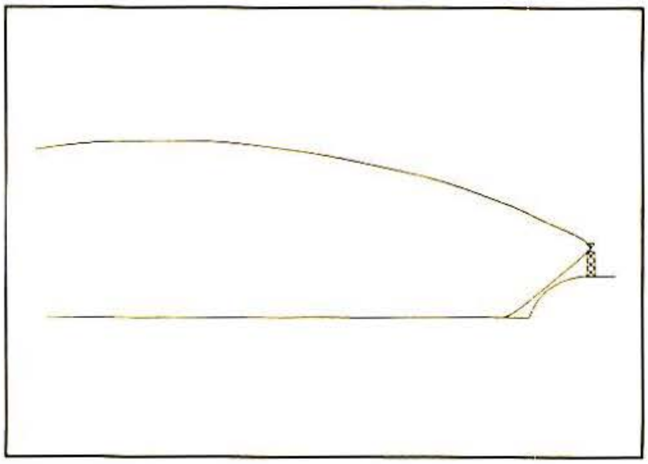

Figure 7. Coverage is provided to almost all the desired area by signal in the antenna's main lobe.

area is available from the authors at no charge.

The F/B ratio myth

When an antenna is placed in a suburban or urban environment and the mobile antenna is low compared to surrounding buildings, the cell-site antenna pattern as received by the mobile can differ greatly from the predicted, free-space pattern.

Because the signal broadcast to the front of a directional cell-site antenna reflects from the surroundings, energy is scattered to the rear. Typically, signal measured to the rear of a directional antenna may be as little as 10dB down from the forward direction, regardless of the antenna's free-space front-to-back (F/B) ratio.

VSWR myth

Have you ever wondered where antenna manufacturers got the 1.5:1


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VSWR specification they generally use to describe as the maximum acceptable VSWR across a cellular base antenna's frequency range? No one seems to know for sure, but the number makes sense, nevertheless.

Assuming the feedline between the antenna and the base station equipment has 3dB attenuation, a VSWR of 1.5:1 increases the loss because of load mismatch by 0.2dB and an additional heating loss of 0.18dB. The 0.18dB loss is spent in heating the conductor in high-density current maxima.

Thus, the entire loss because of VSWR is 0.38dB, an amount whose effect on system coverage is undetectable.

If the VSWR is 2:1, the load mismatch loss is 0.4dB, and the heating loss is 0.5dB, a 0.9dB total. A loss of 0.9dB is quite small, because 1dB is considered to be the smallest noticeable change.

...so the choice should be made based on the lowest common denominator...

Actually, for receivers and for most transmitters, a 2:1 VSWR is acceptable. The problem is that some solid-state transmitters are built with protective circuits that reduce their output power when VSWR exceeds 1.5:1.

The same antenna often is selected for transmitting and receiving, so the choice should be made based on the lowest common denominator, namely, the transmitters that require a VSWR no greater than 1.5:1.

At the same time, an antenna with a VSWR less than 1.5:1 offers no increase in system coverage compared to an antenna with 1.5:1 VSWR.

Remember, although a particular antenna beamwidth and downtilt work well at one site, the combination may provide poor results at another. Engineering experience and calculations can help to define the characteristics of the best antenna for a given site.

'Goodwill Games' software creates a paging 'tree'

Paging service software developed to allow a form of dispatch communications is finding uses among paging customers. The software has five levels of group calling plus individual calling.

By R.L. Silver

The question from the Seattle Organizing Committee (SOC) of the 1990 Goodwill Games was simple and direct: Can competition results be delivered almost immediately to journalists covering the games?

Engineers at McCaw Cellular Communications, the parent company of Telepage Northwest, Seattle, were confident they could provide the technology to do it, even though it had never been done before at a large, Olympic-style event.

Silver, a former *Seattle Times* editor, is a free-lance writer who lives in Seattle.

Tim Frey, an engineer and the pager repair manager for McCaw, worked with SOC officials and software engineers from Starsung Technologies, Denver, to define the system's characteristics:

- *Simultaneous paging*—Simultaneous, groupwide distribution of results was necessary to help the SOC to reduce the "new release paper chase" that commonly hampers journalists who cover large-scale sporting events.
- *Subgroup paging*—Some messages, especially those directed to operational staff, required simultaneous distribution to a subgroup of pager users.
- *Individual paging*—The SOC needed the traditional paging capability of directing a message to a specific individual.

A Seattle Organizing Committee staff member prepares to send event results via the Goodwill Games alphanumeric paging system developed as a special application for Telepage Northwest, Seattle.

"A good example of the SOC's needs was paging for its transportation department," Frey said. "Within that group, there was a bus fleet and a van fleet; within those groups were management and staff. The SOC needed the ability to page the entire department, just the bus fleet, just management within the fleet or one individual, and so on."

To satisfy the requirement, Telepage engineers designed a system that delivers messages over a system of alphanumeric pagers.

"The structure was complicated to build," Frey said. "The way we ended up presenting it on the computer looks like a tree."

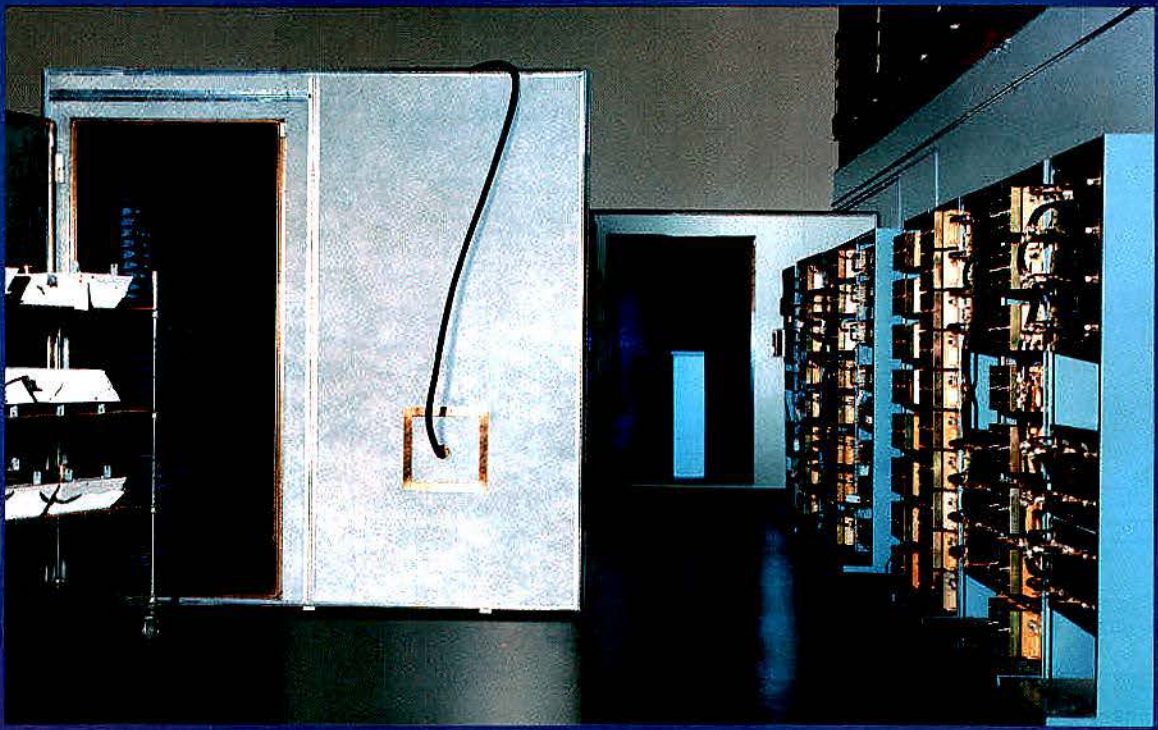
Dispatch operators, Frey explained, see a visual representation of a tree on their computer screens. The tree trunk represents the ability to page an entire group simultaneously. Branches represent subgroups that may be sent messages simultaneously. Twigs on the branches, so to speak, represent individual pager users.

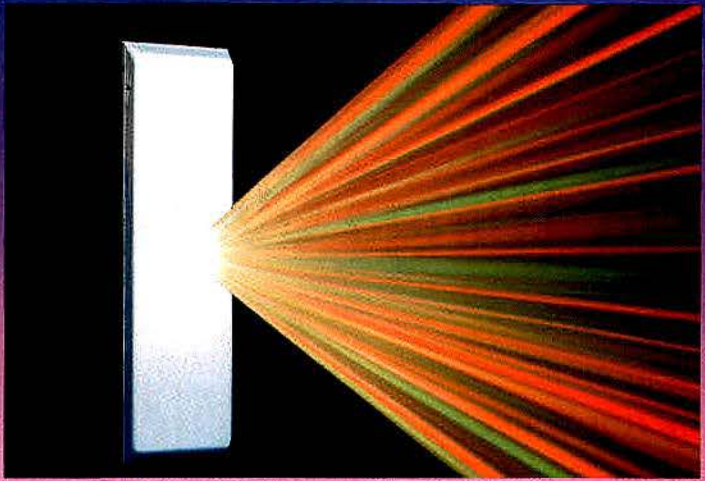
"You work from the trunk to page an entire group, then branch off to subgroups and finally to individuals within those subgroups," Frey said.

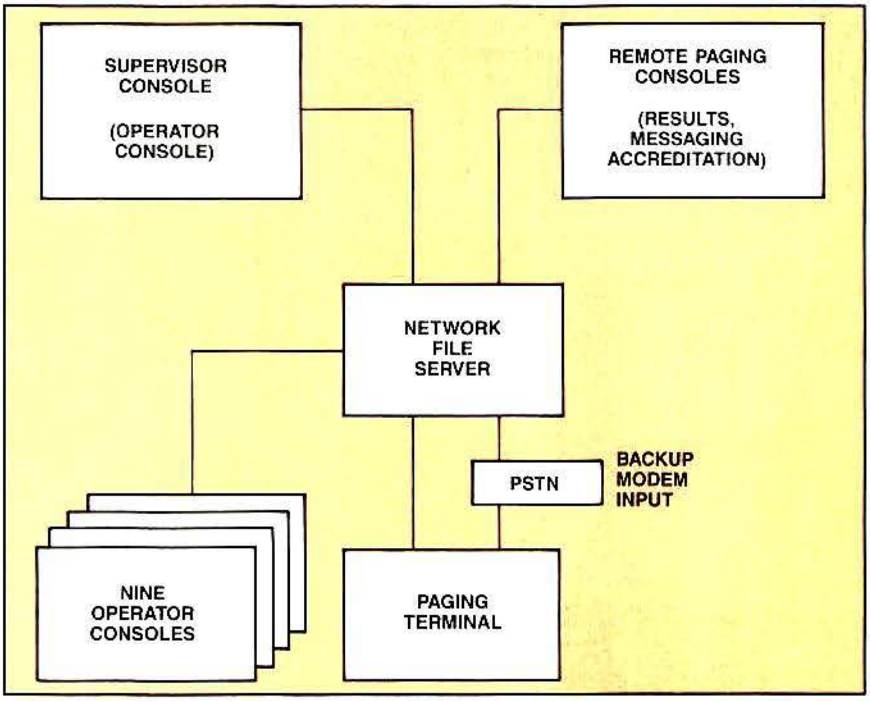
The games

The Goodwill Games, like the Olympic or Pan-American Games, would have been a logistical nightmare without modern communications. Between July 20 and Aug. 5, 1990, nearly 2,500 athletes competed in the 17-day, 21-event competition that was covered by more than 1,300 reporters from throughout the world.

Assisting in the operation of the games and its television coverage were







The alphanumeric paging arrangement used by the Goodwill Games Seattle Organizing Committee included nine centrally located operator consoles for messages telephoned to the paging service and a number of remote paging consoles used to distribute event results from venues across Washington state.

250 SOC staff members, more than 11,000 volunteers and nearly 2,000 employees of Turner Broadcasting System (TBS). TBS beamed 86 hours of prime-time cable coverage to U.S. subscribers. Nearly all of these people wanted the results right away.

Telepage supplied 3,000 pagers to SOC officials, volunteers and journalists. "We jumped at the chance to develop a system for dispatching even results," said Jim McGrath, Telepage's general manager. "It was a great way to demonstrate our technology. In addition, it gave us the opportunity to develop a new dispatch system that provides long-term benefits to our customers."

Customer benefits

Telepage's regular customers now have the use of a system flexible enough to deliver pages to the entire network or any portions of it, down to specific individuals. The system allows partial name searches to help operators to identify customers without an exact spelling

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of a name. The system stores messages to allow customers to call for their messages after having been outside the service area.

"We did large group calls for other customers before, so the basic idea is one we already used," Frey said. "It was a matter of tailoring the idea and expanding it quite a bit. We didn't have any 3,000-pager groups prior to the SOC.

"Enhancing the group-call capability really came down to two steps," he continued. "First, we developed the software. Second, we installed a Glenayre Electronics paging terminal capable of running the upgraded software."

Paging 'slots'

Frey, together with software engineers from Starsung, developed a method for programming the 3,000 NEC IDP 7000 pagers with six identities. These identities, also known as slots and capcodes, correspond with each branch in the paging tree.

"Slot one is the individual pager. As you go up in slot numbers, the higher slots represent larger and larger groups of pagers," Frey said.

Slot two was not used. It was held in reserve as an available subgroup.

"It was a matter of tailoring the idea and expanding it quite a bit. We didn't have any 3,000-pager groups prior to the SOC."

Slot three was for titles and class.

Slot four was used for groups.

Slot five included individual departments.

Slot six encompassed the entire system.

Jim Murray, SOC director of technology, said: "The way the pagers were grouped, we were able to target a certain venue. We could tell all of our people at that venue that the Goodwill Games competition event had been delayed by 30 minutes, for example, by creating one message and sending to the people at that stadium. The instant communications made everyone's life easier."

Cellular telephones

The SOC used the dispatch software and paging equipment in conjunction with cellular telephones to create a virtually fail-safe communications network. Cellular One, another McCaw affiliate, supplied the SOC with 1,500 cellular telephones as part of a $1.4 million contribution of cash and services.

"Everyone who carried a phone had a pager," Frey said. "Phones were conditionally forwarded. If the phones were busy or not answered, the calls reverted

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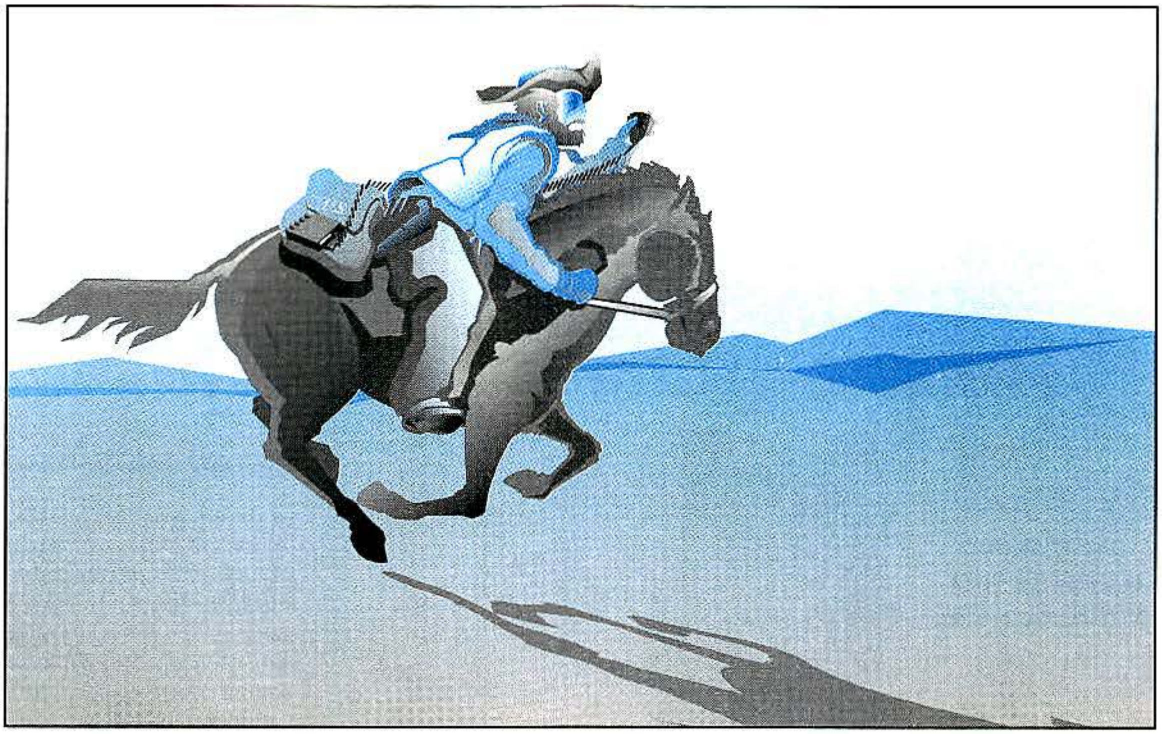

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to the respective pagers." At that point, the caller would hear a tone. "After you heard the tone, you entered your phone number or called another number to have an operator install an alphanumeric message. It is kind of like carrying around electronic mail."

Murray expanded upon that point. He said people equipped with pagers and cellular telephones virtually carried their desks with them.

"Nobody ever had to sit at the end of their phone," Murray said. "We had to be mobile. Even at the venues, we would be moving around. It was the only way to get in touch with people. One way or the other, we got the guy you were calling."

The most intriguing application, though, may have been the event-result distribution via the alphanumeric pagers.

Frey explained: "In the past, reporters always huddled outside a trailer and waited for results to be run off on a copying machine. It took about 20 minutes, and that was for a high-priority event."

Frey said pager users looked to Telepage to deliver event results in less than a minute, though a given pager user might be anywhere in Washington state. Venues were in cities at both ends of the state.

"We had to be mobile. Even at the venues, we would be moving around."

To satisfy the wide-area coverage requirement, Telepage installed a network of 900MHz paging transmitters that linked eastern and western Washington state for the first time. Planned expansion of the system will extend seamless paging from Canada to the Oregon-California border.

Paging nurses

Other customers are finding uses for the dispatch software developed to serve the SOC. First Nurse, a Seattle company that supplies nurses on a temporary basis to surgical teams, hospitals, respiratory care units and nursing homes, plans to make use of the paging tree.

"First Nurse is upgrading its paging capability from situations in which it has either systemwide paging or no paging at all," Frey said. "The reasoning is simple. Why send a message to all the nurses if the message is needed only by the respiratory nurses?"

The alphanumeric pagers Telepage uses have liquid crystal displays and hold more than 7,000 characters of messages. The messages are sent via an narrowband FM channel at 512 baud.

Telepage general manager McGrath said: "The system truly is high-tech, and the Goodwill Games served as a great test case for the technology."

Radio coverage design and system optimization

Real world coverage analysis may not be the best preliminary radio coverage design tool. Less expensive shadow plots and simpler propagation models may guide the designer to an optimum working system.

By Mirza Ahmad

Mobile radio communications system design involves radio coverage, which is difficult to predict. Nevertheless, predictions are necessary—and sometimes controversial.

Along with the system user, others have an interest in the predicted radio coverage: the FCC, lawyers, technical consultants, engineers, hardware suppliers, operators of neighboring systems, competitors and site owners.

'Real world' analysis

Some system designers claim superiority for in-house, *real world* coverage models. Moreover, mobile communications technology is migrating to frequency bands above 800MHz. These two factors increase interest in radio coverage analysis. ("Real world" refers to computerized methods of approximating field conditions with high-resolution terrain data and the best radio propagation model for a given frequency.)

Real world coverage analysis may seem especially attractive because the turnaround often is quick, and the results may predict coverage more accurately than other methods. But sometimes these analyses are mysteriously inaccurate when compared to field tests.

Radio coverage improvement is not a matter of choice, such as specifying the tallest tower, a powerful transmitter and a huge, high-gain antenna. FCC regulations, building codes, budgets, potential interference and other factors limit the choices. System designers demonstrate their craft by defining an optimum system within these limitations.

A well-designed system reduces capital expense. Yet sometimes systems are grossly over-designed because of fear of underestimating radio coverage. Over-designing is a disservice to the client because it costs more. It is a disservice to neighboring system operators because it increases the interference potential. It extends frequency reuse distances, unnecessarily burdening an already heavily used radio spectrum.

Digitized terrain data and computerized real world coverage models have combined to make coverage predictions more accurate and easier to produce. But an optimum system design may be elusive to the designer who relies too much on real world coverage analysis.

Real world coverage is predicted with Bullington, Okumura or Longley-Rice radio propagation models or variations of them, in combination with an accurate, digitized terrain database.

An alternative method for the initial design stages, such as a *shadow plot*, may produce better results, especially at frequencies above 800MHz.

Shadow plot

In the 800MHz and 900MHz bands, terrain near the transmitter site is such a dominant factor in determining coverage that, together with free-space loss, it accounts for most of the signal loss. Thus, a terrain shadow plot that displays a line-of-sight area from the transmitting antenna to the receiving antenna is a satisfactory planning tool in place of a real world coverage analysis. There is little difference between the results of a shadow plot and a real world coverage analysis for hilly or mountainous areas at 800MHz and 900MHz.

Where terrain is not so hilly, either

Ahmad is senior engineer at SFA, Landover, MD.

Coverage planning tools

Real world coverage analysis

- ☐ Digitized terrain data.
- ☐ Bullington, Okumura, Longley-Rice radio propagation models or variations of them.

Simple coverage planning tools

- ☐ Shadow plot.
- ☐ FCC Carey model.

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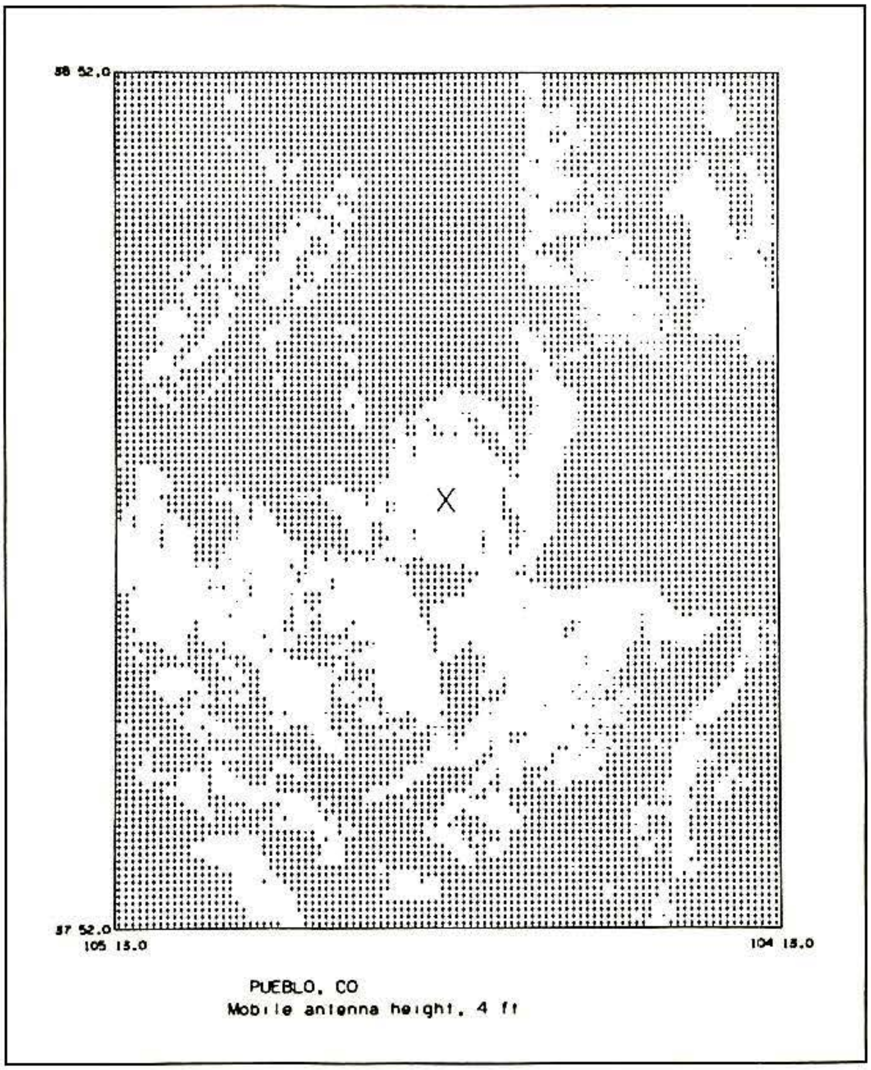

Figure 1. White areas in this shadow plot show ground-level areas within a line-of-sight from a 4-foot-high mobile antenna in Pueblo, CO.

a simple propagation analysis or the FCC Carey model is satisfactory as an economical coverage *planning* tool.

When the proposed system does not involve multiple sites with large coverage areas, real world coverage analysis should be avoided because it is too costly and excessive for early system planning.

Using real world coverage analysis for early system planning might be justified in frequency-congested areas with a high interference potential. But when engineers face complex interference situations, they usually resort to manual terrain interpolation and interference analysis.

Even when only one site is available for a proposed system, a shadow plot provides useful information for hilly areas. It shows areas of relatively strong and weak coverage, including the radio horizon. It guides system designers on antenna orientation for directional antennas and other design information. Figure 1 above shows a shadow plot.

Later, during field testing, predicted radio coverage can be—and usually is—redefined.

When coverage field test results differ from detailed real world coverage predictions displayed by glamorous, multicolored predicted radio coverage contours, a followup analysis almost always is made.

Radio coverage is *unique* to each site, a fact that may be forgotten or overlooked when preliminary system designs

Why coverage goes wrong

Predicting 100% accurate coverage during the initial design stages is impossible. Several factors may cause actual coverage to differ from predicted coverage.

- ☐ **Side-mounted antennas.**
- ☐ **Omnidirectional antennas with excessive gain.**
- ☐ **Foliage.**
- ☐ **Weather.**
- ☐ **Soil.**
- ☐ **Multisite interactions.**

are made. It is impossible to fully account for *all* factors affecting coverage in the predicted coverage analysis. It is useless to be obsessed with predicting 100% accurate coverage during the initial design stages because there are several ways in which coverage can go wrong.

Unique site features

The site can have such a dramatic effect that actual coverage may barely resemble predicted coverage.

With a top-mounted antenna and no other antennas at the site or nearby, coverage problems are simple to tackle. All hardware should perform as expected, otherwise coverage is affected.

Check the antenna alignment to verify that it is vertical or tilted at the specified angle. A slight, undesired tilt can ruin coverage in some directions.

Confirm transmitter frequency stability, power and VSWR are within specifications. Measure transmitter power into the antenna to confirm expected cable and connector losses. Inspect rooftop antennas for appropriate clearance from the roof to avoid deflecting the signal's vertical lobe.

The situation gets complicated when the antenna is side-mounted and positioned near other antennas, a configuration sure to affect radio coverage. Side-mounting causes pattern distortion that seldom matches the antenna's published pattern. Coverage is too difficult to predict accurately for a system with a side-mounted antenna on a crowded tower.

Thus, the usefulness of a real world coverage analysis based on design conditions is questionable. After the system is built and testing reveals the actual operating conditions, a real world coverage analysis might be accurate. But assumptions and guesses as to what the field conditions might be should not be used as a basis for a real world coverage analysis.

Antenna

Not all antennas with the same gain figures are created equal.

Maximum horizontal gain is only one antenna characteristic that affects coverage.

The vertical lobe many times is not taken into account in coverage design, an oversight that may cause problems later. An extremely narrow vertical lobe can overshoot the intended target area, especially from high-elevation sites.

In downtown districts, lower-gain antennas with wide vertical lobes can cover the area more reliably with less multipath fading. Extremely high-gain antennas in downtown districts perform erratically, primarily because of increased multipath fading.

Although lower-gain antennas may not cover great distances compared to high-gain antennas, their superior close-in coverage often justifies their use.

If the same antenna is used for transmitting and receiving, use one with sufficient bandwidth to cover transmit and receive frequencies within accept-

able gain limits.

Local conditions

A real world coverage analysis based on erroneous assumptions about local conditions is flawed, of course.

For example, radio signal attenuation caused by foliage may vary from 0dB to 25dB, which gives this factor great importance. If foliage losses are estimated incorrectly at 7dB when the accurate value is 13dB, a 6dB error is introduced into the coverage prediction.

Similarly, weather conditions, such as moisture and humidity, must be estimated properly. The difference in weather conditions between Tucson, AZ, and Seattle may be reflected in a 2dB-to-5dB difference in radio propagation loss.

Radio signals are absorbed and reflected differently by various types of soil, a factor that may distort the results if the assumption used in the calculation is incorrect.

The list goes on.

Propagation engineers who work in remote offices usually do not know all local conditions accurately. They must rely on information from their clients, and that information may not be as accurate as it should be.

Problems and unique situations

Some situations demand special solutions.

For example, to deliver radio coverage inside a tunnel, special engineering is required. The external radio system usually cannot be relied upon to do the job.

An external radio system may be unable to cover certain buildings. A subsystem of repeaters or distributed antennas made of leaky coaxial cable may be required.

Downtown buildings sometimes are aligned in such a way that moving the transmitting antenna a few feet may solve a coverage problem.

Multisite systems are unique and challenging because individual sites must be arranged to complement each other's coverage. Shadow plots often are quite useful in planning multisite systems because they can help to select complementary sites that cover areas on either side of a terrain obstruction. Selecting complementary sites requires radio propagation knowledge and an understanding of the different frequency bands' limitations.

Art and science

Real world radio propagation can be complicated and may differ greatly from theoretical predictions. Designing radio coverage is an art and a science. Too many variables and unique situations enter into the process for it to be generalized into a real world coverage model. Thus, propagation engineers use probabilities in their predictions and allow for error in the predicted coverage results.

The more variables that are accounted for and the better they are estimated, the more accurate the coverage predictions. Even so, field conditions may differ from the best possible predictions.

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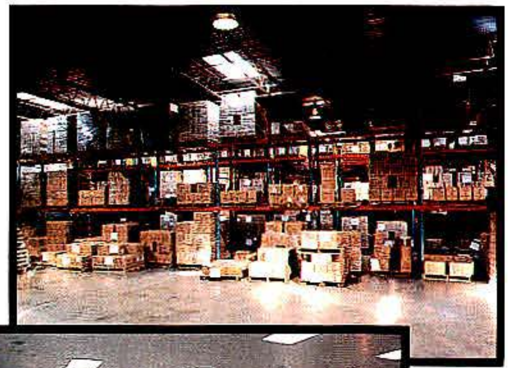
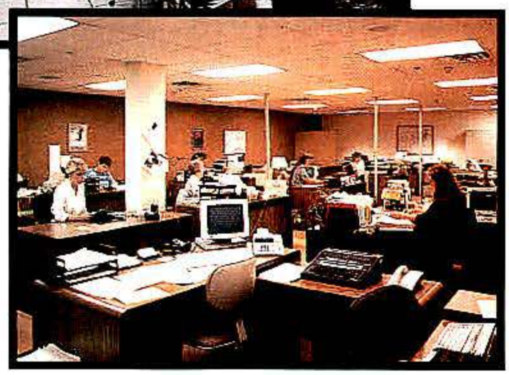


Repair and Technical Support



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Circle (49) on Fast Fact Card

In-building wireless communications system predicted

Wireless in-building communications systems are predicted to infiltrate the business communications marketplace, according to Alexander Resources, Scottsdale, AZ. The market research company speculates the business wireless communications market will soar to $2.1 billion annually by 1997.

With personal communications networks evolving, Alexander's research points to private PCN services as being more likely to materialize. "We think this concept of one phone for everybody to be used anywhere may not really be a market reality, much less a technical reality," said president Jerry Kaufman.

The company studied the business communications market and conducted a survey of 300 businesses to see how they would use wireless communications systems. "We found the need for in-building wireless telephone system for business users," he said.

The "Wireless In-Building Business Communications Market Opportunities" report shows that a number of employees could benefit from in-building wireless telephones that are equipped with features needed for business use.

Problems with current wired business communications include:

- Not being able to reach people who are away from their desk and office.
- Being away from a telephone and missing important calls.
- Time and expense wasted returning missed telephone calls.
- The impracticality of using a cellular or cordless telephone, a pager or a two-way radio indoors because of costs and technology constraints.
- Costs and problems associated with telephone wiring systems.

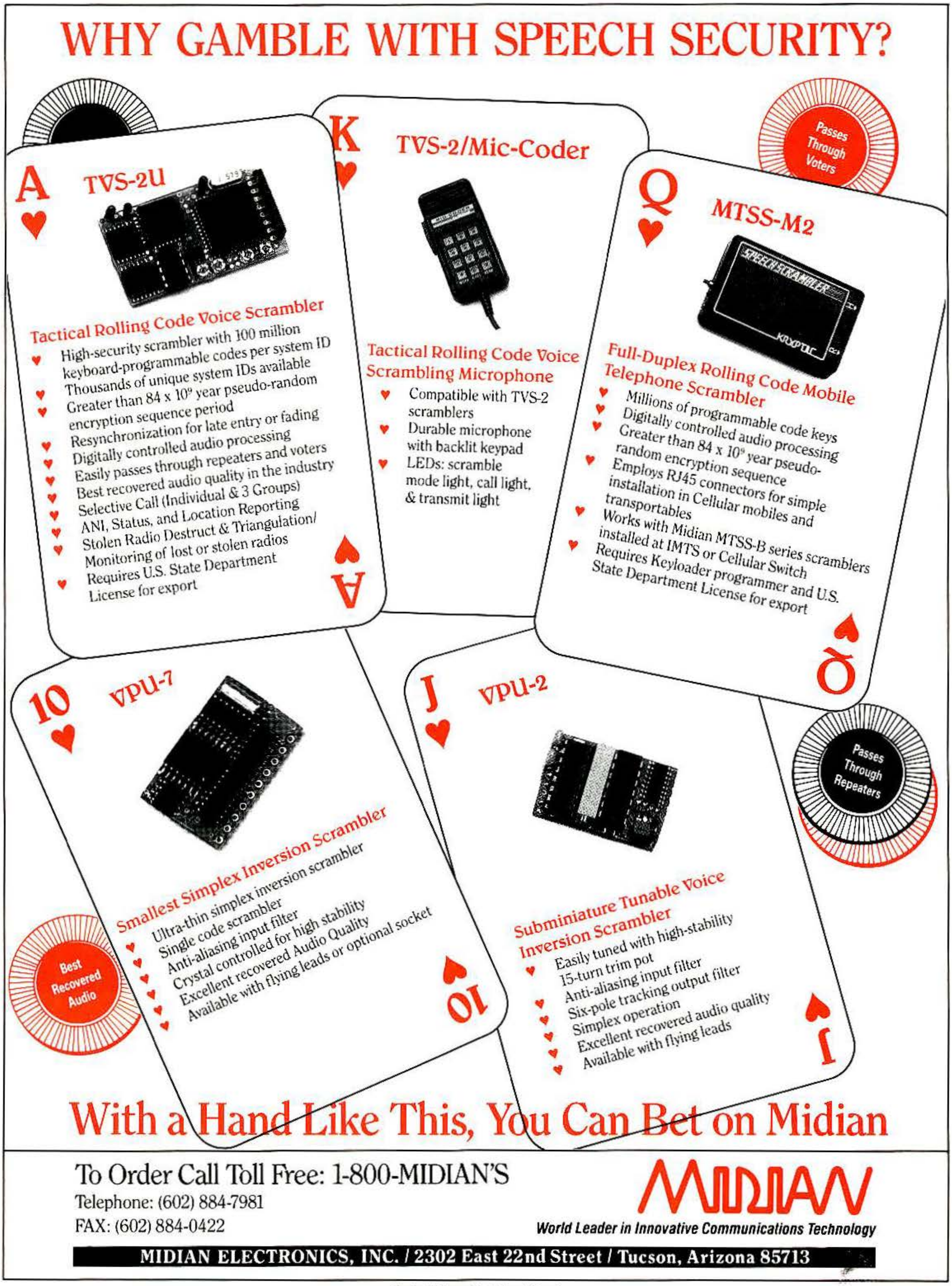
Because of these factors, Alexander's research identified the need for two basic forms of wireless communications systems: a multicell, multi-user system for large business facilities and a single-cell, multi-user system for small facilities. Each of the systems can operate as stand-alone systems or as an adjunct to existing dedicated telephone lines, private branch exchanges, key telephone systems or other telephone systems.

The wireless communication systems or private PCN business market will be addressed by traditional telephone marketers, PCS providers, LECs, cable television and cellular providers, as well as other suppliers, Alexander reports.

Already Motorola, Northern Telecom, Ericsson, SpectraLink and Rose Communications are gearing up to offer products aimed at this segment, according to Alexander.

CPI relocates

CPI Communications has moved to 1186 Commerce Drive, Richardson, TX 75081. The company maintains its phone number of 214-437-5320.



Circle (62) on Fast Fact Card

Pc board with POCSAG decoder enables electronic data

TGA Systems, Atlanta, has signed an agreement with Swissphone, a Samstagern, Switzerland-based manufacturer of pagers for the European market, to distribute its R-Mail module in the United States.

The R-Mail product enables electronic radio data transmission. Swissphone makes a printed circuit board with a receiver and POCSAG decoder into a form that fits in the modem slot in the Toshiba laptop line, according to David Freeman, TGA vice president.

Swissphone has an agreement with Toshiba Europe for the modem. With the modem installed in a Toshiba laptop computer, users can pick up any data while on the move. The electronic radio product can send as much as 100,000 characters of data to the computer even when the computer is turned off, according to Freeman.

TekNow team with Reuters to deliver data

TekNow, Phoenix, has undertaken a project with Reuters Information Services to deliver data to Reuters' Pocketwatch hand-held terminal. TekNow devised software to link paging to the Reuters' product.

The electronic publisher's hand-held terminal subscribers can receive news and financial information from around the world with the paging tie-in.

ARDIS, RF Data sign software marketing pact

Radio Frequency Data Network Systems, Hinsdale, IL, and ARDIS have signed a pact for RF Data to design custom communications software for ARDIS customers. The ARDIS public radio data network allows computers to communicate by transmitting data over radio signals. RF Data's software will interface radio frequency devices and host computer systems.

NEC begins era of retail pager distribution

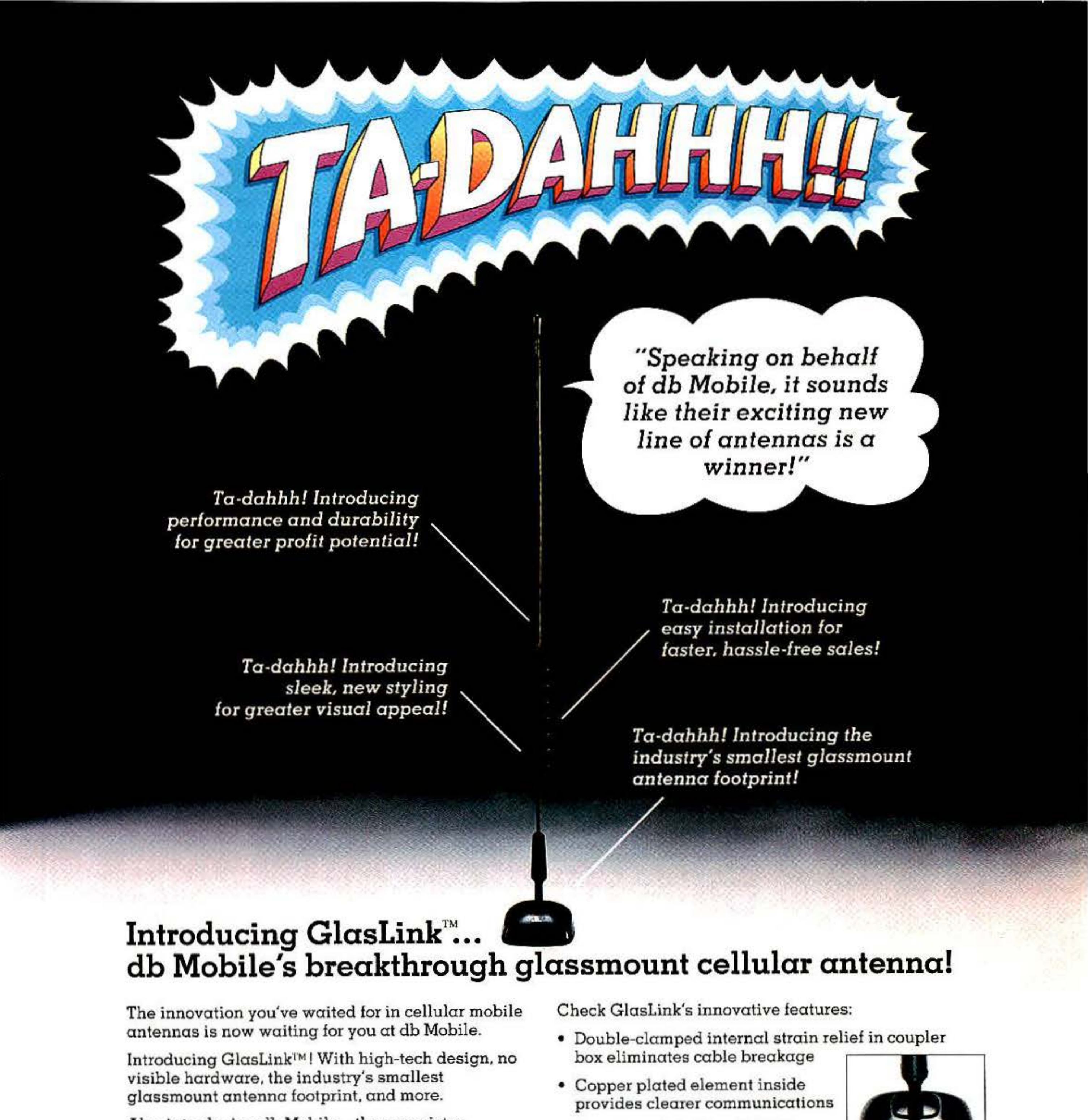
NEC, the second-largest paging manufacturer in the world, has developed point-of-purchase materials for retail pager sales. The Richardson, TX-based company is marketing its IDP 500 pager for retail distribution via carriers. The carriers will sell the product to retailers.

"We have large carriers that are selling 1,000 plus pagers a month via retail," said Tom Heatherington, vice president of paging sales.

Carriers will target retailers from small mom-and-pop outlets to larger stores, according to NEC. The company expects retail distribution through stores such as SAMs Wholesale Club and Sears.

Valor names rep

Valor Enterprises, West Milton, OH, has picked Robert Milsk Company as an Omni gain representative. The rep firm is at 22420 Telegraph Road, Southfield, MI 48037.



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Circle (63) on Fast Fact Card

AT&T, SkyTel promote wireless with notebook computer

AT&T, Basking Ridge, NJ, and SkyTel, Jackson, MS, have joined forces to make possible a wireless mailbox linking electronic mail and paging capabilities with a notebook computer.

AT&T's Safari notebook computer receives wireless messages from SkyTel's satellite-based messaging service. With the SkyTel network and SkyTel Link, Safari notebook users have a wireless mailbox to receive electronic mail at any time and throughout North America and other parts of the world.

AT&T and SkyTel have the first North American-wide messaging capability for a notebook computer. Subscribers will be able to use their wireless mailbox within other countries that offer nationwide paging services affiliated with SkyTel in the future, including the United Kingdom.

KNS purchases Cushman service facility

KNS Enterprises has purchased the Cushman service facility in San Jose, CA, and the CE 7120 and CE 6030 Cushman products. KNS will retain Cushman employees in San Jose and will relocate to 2146 Bering Drive, San Jose, CA 95131; phone 408-432-8100. KNS corporate headquarters are in Atlanta.

Canada to launch national dispatch center

A national alphanumeric paging dispatch center for Canada is anticipated to be operational early this year. The National Dispatch Center, San Diego, will construct, install and test a system under contract from National Pagette, which serves more than 147,000 subscribers in Canada.

National Pagette will own and operate the Canadian center under terms of a National Dispatch licensing agreement. National Pagette and National Dispatch plan to interconnect the Canadian and American centers.

In another contract, National Dispatch will provide Newsmaster pager alerts to alphanumeric subscribers across the country of Anterior Technology, Menlo Park, CA. Anterior provides E-mail and information services.

Hutton adds stocking locations

Hutton, Dallas, has added two stocking locations, one in Atlanta and the other in Denver. The Atlanta facility will serve the Southeast region. A merger with Communications Works, Denver, adds warehouse space to serve customers in the Rocky Mountain and Pacific Northwest region.

Making sure certified technicians move ahead

By Thomas Green

The volunteer leadership council of the Association of Communications Technicians (ACT), a membership section of the National Association of Business and Educational Radio (NABER), met during NABER's annual Fall Meeting in October 1991 in Alexandria, VA. NABER's leadership and staff met to discuss issues pending within various membership sections.

Certified technicians face unique problems. Here are matters that the ACT Council has discussed:

► *Certification requirement*—A government requirement for technician certification is worth pursuing, even though eventual implementation may take several years. The reasons are to increase the technicians' level of competence and to help to curb unlicensed operation of radio communications transmitters.

► *Specialized exams*—The council asked the technician certification technical committee to consider whether to establish specialized exams to certify proficiency in specific areas of technology. Because of the potential demand for highly trained, specialized technicians, certification in specific areas of technology gives the technician a valuable competitive advantage.

► *Regional chapters*—To meet the special needs of technicians in certain parts of the country, the council plans to establish regional chapters. The first regional chapter is to be organized in the Missouri-Illinois area.

► *Membership development*—The council will increase efforts to recruit members among new technicians.

► *Unlicensed operations*—The council is working closely with NABER's Unlicensed Operations Task Force, the Association of Mobile Radio Dealers, congressional representatives and the FCC to develop legislation to stop unlicensed operation of radio communications transmitters.

Recognizing that ACT includes an active membership of more than 1,600 certified technicians, the council establishes policies intended to elevate the status of certified technicians.

Green is ACT leadership council chairman and communication electronics instructor, Ranken Technical College, St. Louis.

Information

For information about ACT and technician certification, call 800-759-0300. Ask for "technician services."

Automatic identification prevents FCC station ID violations

Some two-way radio users consider station identification (using their call signs) to be an unnecessary burden. But according to FCC electronics engineer Judah Mansbach: "It is required under the commission's regulations. That is why many licensees have opted to install automatic and Morse code station identifiers."

Mansbach, who works in the agency's Field Operations Bureau New York office, said he would like to see more use of automatic IDs: "If everybody identified, it would make our life a lot easier. We would be able to identify the stations involved in an interference situation quickly and resolve it. Some types of transmitters in the marine radio service, for example, have had built-in automatic station identifiers for many years."

Mansbach said the greatest number of complaints from land mobile radio operators in New York involves co-channel interference—two people on the same channel trying to use the airwaves at the same time.

"Another type we get involves interference by the licensee to television sets and other home entertainment equipment," he said.

A third source of complaints stems from transmitter defects transmitter that may cause a problem to other radio services. "You take a city such as New York where you have dozens of transmitters in one location. This would tend to cause more transmitter intermod problems than might otherwise be the case," Mansbach explained. "The size of the problem is unique to urban areas with large licensee populations."

FCC approves 931.4375MHz for interstate use by Mtel

Mtel, Jackson, MS, has won FCC approval to use 931.4375MHz for interstate paging, free from state regulation and any requirement to carry local paging. The frequency is adjacent to Mtel's nationwide paging frequency used for its SkyTel national paging service.

Seattle FCC office relocates to Kirkland

The FCC's Seattle regional and local FCC offices have moved from Bellevue to Kirkland, WA. The offices share the same address and telephone number: 11410 NE 122nd Way, Suite 312, Kirkland, WA 98034; 206-821-9037.

The regional director's office provides administrative coordination and guidance to local FCC offices in Washington, Alaska, Hawaii and Oregon.

The local office handles inquires about telecommunications, resolves complaints about electronic interference and schedules radio operator exams.

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Circle (69) on Fast Fact Card

Policy statement on fines concerns common carriers

The FCC has issued a policy statement with different base levels of fines that are going to be issued for different kinds of violations, and this has common carriers upset. There are different base levels for mass media broadcasters and common carrier licensees, and common carriers believe the fines are too steep.

According to Gregory Vogt, chief of the Common Carrier Bureau's Mobile Services Division, "The fines are a lot higher for common carriers than mass media (broadcasters)—the maximum is $1 million for common carriers and $250,000 for mass media. The base levels reflect that distinction, and most of the base levels are four times higher for common carriers."

There has been some concern by smaller radio common carrier (RCC) paging carriers that these fines may be too high. Many have filed petitions for reconsiderations, including Telocator, Vogt said at an FCC panel during Mobile Communications Marketplace, Oct. 21-24 in Anaheim, CA.

"My personal philosophy on this was that the policy statement was a good idea because it gave people notice about what to expect," he said. "The trouble is that it can't be perfectly tailored to every individual situation.

"The statute requires us to take into account the ability of a company to pay as part of the calculus in determining what the fine should be.

"The theory is that the richer the company, the higher the fine should be to make it hurt. You have to be able to deter people from violating the rules," he stressed.

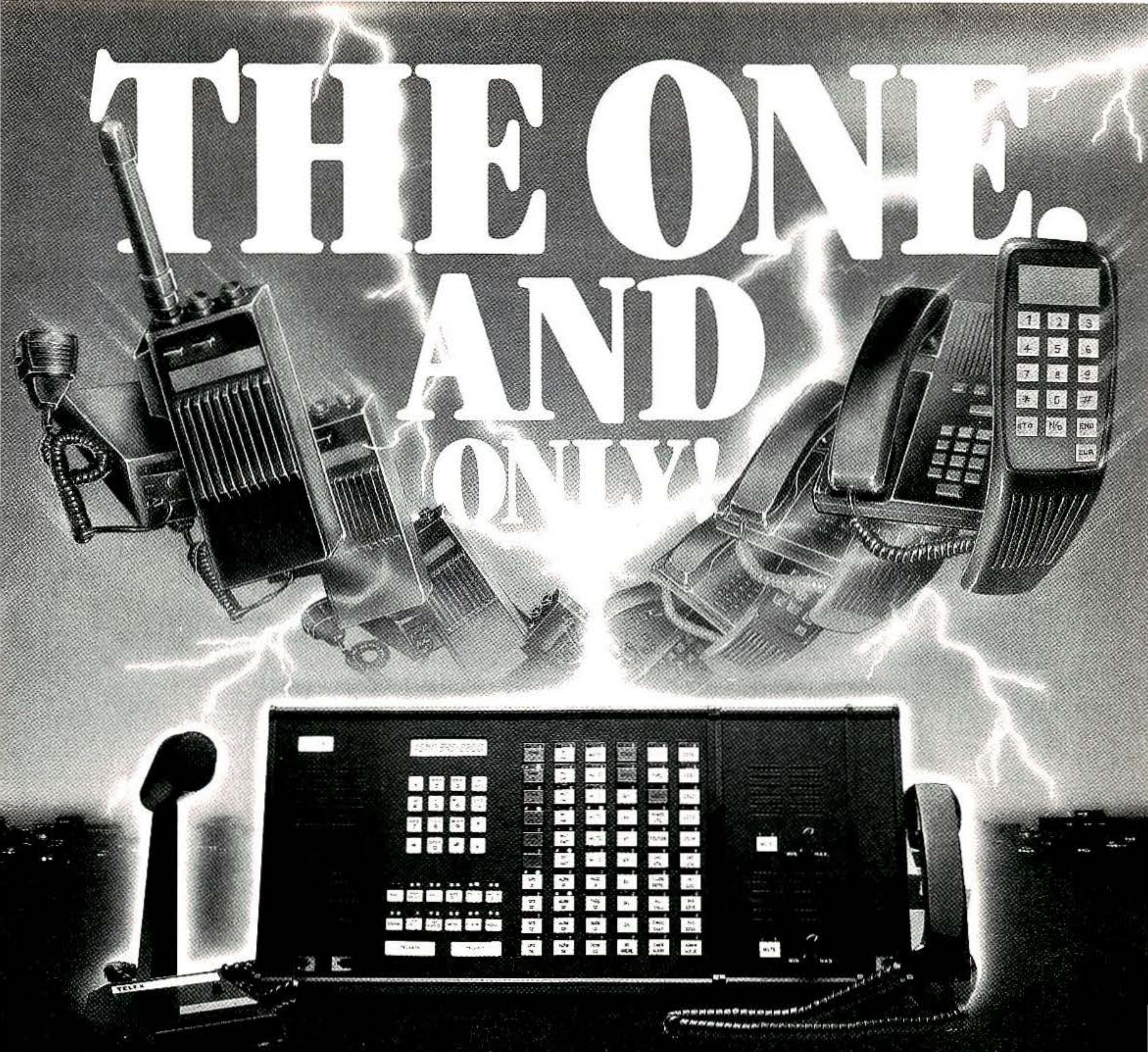
A smaller company does not need to have such a high fine, he said. Therefore, the commission anticipated all along that it would take the ability to pay into account when issuing a fine. "But you can't do that upfront. We don't have the information on companies of how much their annual revenues are, for instance," he said. "We don't have that information on file."

RCCs aren't required to file that information, so the FCC has to get that information later, Vogt explained. It's an imperfect system, but fines certainly can be debated.

If a company's revenues do not justify a certain fine, then the FCC should be prepared to reduce it, Vogt said.

Manufacturers Radio Service may win new channels

Under terms of an FCC proposed rulemaking, users licensed in the Manufacturers Radio Service may gain access to 20 channels from 74.6MHz to 74.8MHz and from 75.2MHz to 75.4MHz in the 72MHz band. The rulemaking stems from the expiration of limits placed on the use of those frequencies to protect reception of aeronautical marker beacons until Dec. 31, 1989.



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Readers' choice

Of all the new products and services in the June issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Cleaner safely removes adhesive from pagers

Clean-A-Page fluid provides a safe way to remove adhesive and labels from pagers. The cleaner from **Anchor Graphics** is biodegradable and OSHA-approved, and it does not harm pager housings. The liquid base smells like orange and shines pagers as well.

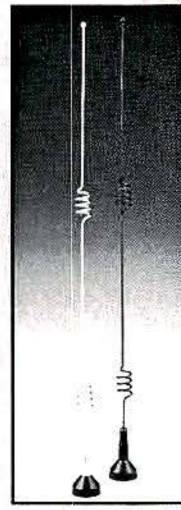
Circle (204) on Fast Fact Card

Shop management software handles inventory

Shop management software version 2.0 from **Pyramid Communications** includes an inventory module and repair orders module. The service shop software includes 15 modules and handles more than 40 separate functions. Capabilities include parts cross-referencing, printed reports on customers, inventory, shop productivity, invoicing and other functions. A demo disk is available.

Circle (205) on Fast Fact Card

Trilinear antennas reach fringe coverage areas



The MAX-8135 and MAX-8355 800MHz trilinear antennas feature two stacked half-wave elements fed by a quarterwave section. The **Maxrad** antennas produce 5dB gain and have a low angle of radiation for fringe area coverage, rural applications and uses where a higher ERP is required. The antennas come in black or bright chrome and fit a standard 3/4-inch mount. Nominal impedance is 50Ω.

Circle (203) on Fast Fact Card

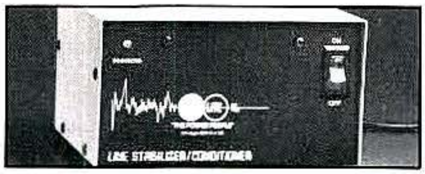
Training course details technical surveillance

The Corporate Technical Surveillance Countermeasures (CTSC) course covers basic theory, communications systems and technical surveillance. Offered by **Ross Engineering,** the course details RF bug detectors (spectrum analyzers and other modern equipment), wire tracers, low frequency receivers and telephone analyzers. Practical exercises in physical search are part of the program, as well as demonstrations of various bugging systems.

Circle (206) on Fast Fact Card

Line conditioners suppress voltage spikes

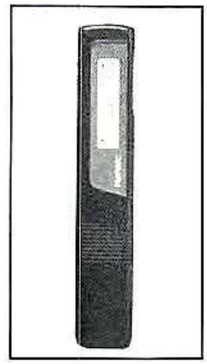
The LS 600 and LS 604 line conditioners plug into a standard 120V wall outlet and regulate voltage and suppress spikes. The **Tripp Lite** units include spike and line noise suppression; circuit breakers; and illuminated on-off switches.



Circle (358) on Fast Fact Card

Pen pager stores as many as 15 messages

The numeric display pen pager uses AAA batteries and stores as many as 15 messages. The **Shinwa Communications of America** pager includes vibrator, dual address, call blocking, battery alarm and direct ROM writing via IBM PC.



Circle (363) on Fast Fact Card

Intercom system suits fire apparatus

The System 1000 vehicular intercom and radio mixer combines noise attenuation for hearing protection with clear voice communications. The **Setcom** unit is designed for fire apparatus and includes volume control. As many as 10 remote headset stations are on intercom and radio monitoring, with only the driver being able to transmit on the radio.

Circle (202) on Fast Fact Card

Tunable Notch Filters 22 - 900 MHz

For suppression of interference to electronic systems:

•VHF/UHF Systems •Broadband LAN •Mobile Radio •Paging •CATV •FM •TV

The 6367 series comprises 6 separate tunable notch filters, each of which covers an approximately 2:1 frequency range with adjustable 3 dB bandwidth.

In CATV, LAN or other Broadband Data Systems, adjacent channel or FM carriers often interfere with reception of a desired channel or data frequency. The notches offer a convenient means of suppression.

Paging Transmitters often overload CATV and other off air reception systems. The exact frequency is often unknown to the offended party. These filters offer a convenient means of "search and suppress."

Mobile Radio receivers often experience intermodulation in their front end, due to reception of a strong, unwanted carrier. These filters offer "front end" insurance against such intermodulation or desensitization.

Laboratory applications include suppressing discrete, unwanted carriers to increase the accuracy of spectrum noise measurements.

Standard models delivered in 3 days.

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Then PHONE or FAX NOW!
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Tunable Notch Filter Type 6367

Standard Models 6367

Model #	Tunable (MHz)
6367-0	22 - 35
6367-1	30 - 50
6367-2	50 - 108
6367-3	108 - 216
6367-4	216 - 450
6367-5	450 - 900

Bandwidth Adjustment
1-5 MHz min.
Notch 20 dB approx. for Bandwidth=3 MHz
Standard:
75 ohm F conn.
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Other connectors available including SMA, TNC, N, C, UHF.

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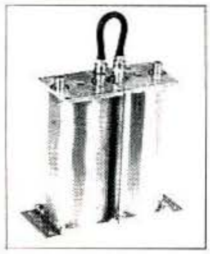
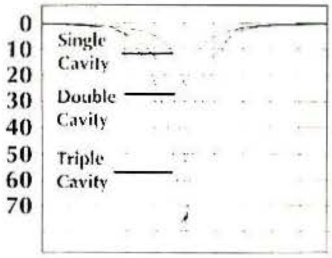


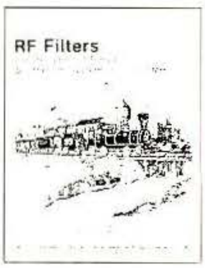
Special models available, including double and triple resonator types with 40 dB and 60 dB notches.



Response of single, double and triple cavity notches with same 3 dB bandwidth.

Details of 6367 series notch filters are given in FREE catalog RF/88, which also describes:

- •Low Pass/High Pass
- •High Power
- •Bandpass
- •Bandstop
- •Preselectors
- •Diplexers
- •Tunable Notch



RF/88: RF Filters 0 - 1000 MHz

Also, ask for FREE catalog The Filter Book - FB/87, a guide to specifying microwave filters.

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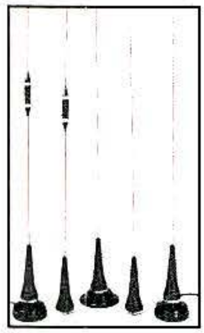
Circle (82) on Fast Fact Card

VHF, UHF transceivers boast multiple channels

VHF highband, VHF lowband and UHF transceivers feature multichannel capability and suit small and large systems. The **Securicor PMR Systems** model 1 features 25W output, four channels, CTCSS and five tone signaling. Model 4 has 10-channel capability, 25W output, and CTCSS and five tone signaling. Model 3 is at the top of the product line and includes an alphanumeric display and keypad. The mobile incorporates a status message function for personal recorded status messages. Model 3 handles full digital signaling within the software.

Circle (201) on Fast Fact Card

Mobile antennas come with black chrome



VHF and UHF mobile antennas from **Antenna Specialists** are available with a black chrome finish at no additional cost. The antennas are offered with standard mounts and are equipped with Dura-Flex elastomer shock springs.

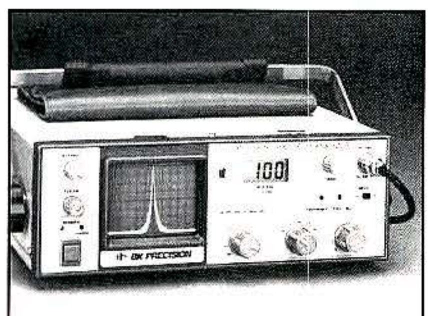
Circle (343) on Fast Fact Card

Intermod software predicts possible interference

Intermod version 2.0 software allows the mixing of as many as 40 transmit frequencies and compares the results with as many as 40 receive frequencies to warn of possible interference. The **Leisure Electronics** software includes functions such as save and load frequency lists to and from disk; output to printer or screen; and output selection of all frequencies or only output of interference frequencies. The program runs on IBM or compatible PCs using DOS 3.1 or higher.

Circle (295) on Fast Fact Card

RF spectrum analyzer handles 1.0GHz range



Model 2610 portable spectrum analyzer from **B&K Precision** uses ac, dc or battery power and spans 1.0GHz frequency range. The tester offers 70dB dynamic range, selectable 1MHz fixed bandwidth settings and rechargeable battery.

Circle (307) on Fast Fact Card

Programmable attenuator spans 30MHz-to-1,260MHz

The P-50-045 programmable attenuator covers 30MHz to 1,260MHz with a VSWR of 1.5:1 maximum. Insertion loss for the **JFW Industries** unit is 3dB nominal. The unit's attenuation range is 0dB to 70dB in 10dB steps.

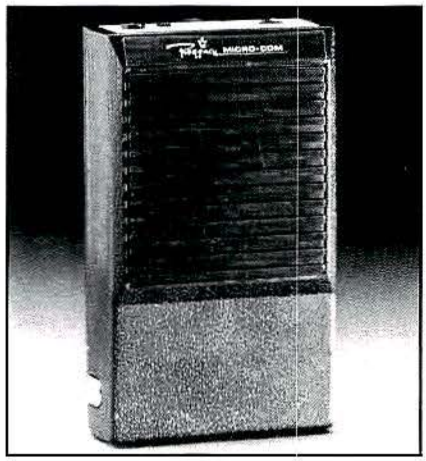
Circle (351) on Fast Fact Card

Low-loss Tx combiners span 850/960MHz subbands

Low-loss Tx combiners from **Wacom Products** include high-performance fixed tuned ferrite isolators. The line spans subbands within the 850MHz-to-960MHz band. The 800MHz combiner line comes with 150W, 250W or 350W isolators.

Circle (335) on Fast Fact Card

Voice, tone pager features alert, monitor switch



The Regency Micro-Com tone and voice pager from **Relm Communications** operates in the 148MHz-to-160MHz range and features a top-mounted alert and monitor switch. Other attributes include a reset button; on and off volume control; and heavy-duty belt clip. The pager comes with a receive crystal, two tone reeds and a NiCd battery. A drop-in battery charger and additional tone reeds are available.

Circle (298) on Fast Fact Card

Radio system design software includes propagation studies

Radio system design software for PCs from **JMA Applied Spectrum Research** suits single and multisite design. The software includes frequency re-use planning, real world propagation studies, and FCC broadcast and Carey contours. The software predicts radio coverage from 30MHz to 12GHz.

Circle (318) on Fast Fact Card

Rapid NiCd charging system conditions cellular batteries

The Discovery Power System conditions and rapid-charges NiCd cellular phone batteries. The **Multiplier Industries** system offers 100% rated capacity, eliminates memory effect and extends battery life. Power Tops are available for Motorola PT500 and PT900 Flip Phone; NEC P300 phone; Oki 700 and 750 phones; and Mitsubishi 3000 and DiamondTel 99X phones.

Circle (346) on Fast Fact Card

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"When Hugo hit, our solid rod PiRod towers just stood there and took it. The storm ripped away many structures in this area . . . I think our PiRod towers were among the very few towers left virtually undamaged. I remember . . . I purchased new antennas, called the people at PiRod for new brackets and we were back in business!"

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For a free guide to tower selection and fast, courteous response to your requests for quotation, contact:

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P.O. Box 128
Plymouth, Indiana 46563-0128
Telephone (219) 936-4221

Medium-density analog radio boasts field-tunability

The TWO-6000 6GHz microwave radio from **Western Multiplex** features field-tunability, multiple baseband outputs, low power drain and two output power options. RF output power is 0.25W or 1W minimum at the antenna port.

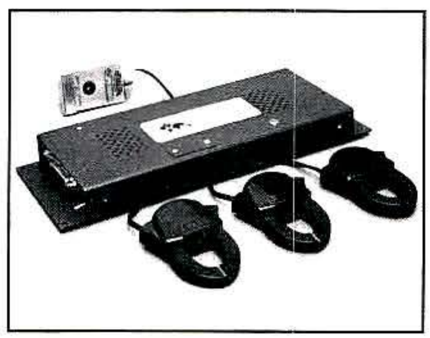
Circle (311) on Fast Fact Card

Wideband UHF portable comes with 16 or 48 channels

Model 70-265C synthesized UHF portable from **Midland LMR** can be programmed over a 32MHz range from 480MHz to 512MHz. The wideband radio is available in a 16- or 48-channel version. The 48-channel radio can be expanded to 99 channels with a plug-in module and offers 4W output, which is switchable to 1W. The portable features priority scan, CTCSS and a 600mAh battery. The radio meets military standard 810C and D and meets intrinsically safe requirements when used with appropriate batteries and accessories.

Circle (383) on Fast Fact Card

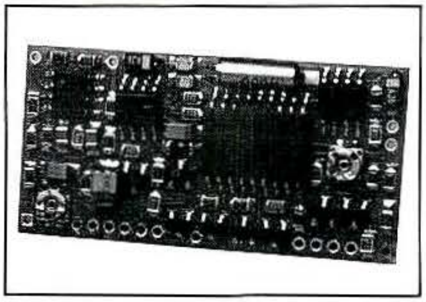
Remote site monitors suit 25MHz-to-1,000MHz systems



Sentry remote site monitors for transmitter and antenna sites control single or dual transmitter sites. The **Decibel Products** monitors come in two models for 25MHz-to-1,000MHz communication systems. Model DB8830TL monitors antenna tower lights and reports alarm conditions within 10 seconds via pager, telephone voice or computer data. Model DB8830G-WT includes a DB8830M Sentry monitor with built-in modem, 120Vac power adapter, battery backup module for ac power failure, high temperature sensor, telephone line protector module and interconnect cables in a standard tray for rack-mounting.

Circle (282) on Fast Fact Card

Man-down alarm unit installs in portables



The PED-24 digital encoder-decoder from **Coded Communications** fits in most portable radios and sends an emergency data message when it senses the radio operator is in distress. The man-down alarm unit has a pre-alarm tone that prevents false emergency messages. The unit will reset automatically upon acknowledgement from the base station.

Circle (361) on Fast Fact Card

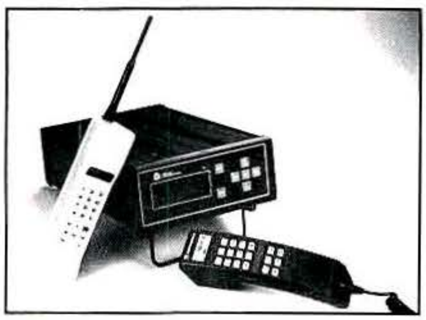
Load terminations boast various power ratings

Load terminations from **Wacom Products** span dc to 1,000MHz and offer various power ratings. Models include 15W, 25W, 60W, 100W, 150W and 225W power units. Screw-on terminations are available in 15W and 25W configurations. Panel-mount terminations include 60W, 100W, 150W and 225W models.

Circle (368) on Fast Fact Card

Cellular phone test system checks 40+ functions

The R-5000 cellular phone test system weighs less than 10 pounds and checks more than 40 phone functions to cellular system standards. Available from **Motorola Worldwide System and Aftermarket Products Division,** the unit measures transmit power, RF frequency and FM deviation, among other items. The unit includes a built-in VSWR meter.



Circle (366) on Fast Fact Card

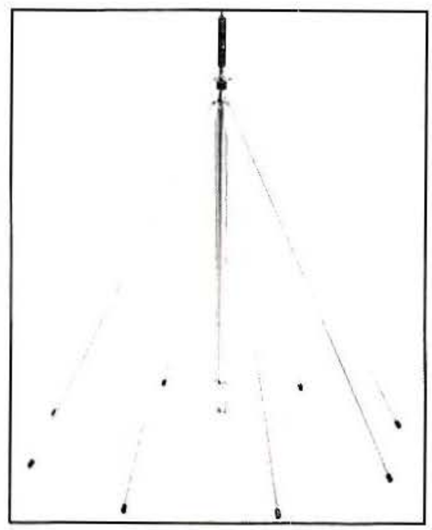
Hand-held transceiver boasts automatic antenna tuning

The PR7077 hand-held transceiver from **Radio Systems** combines wide RF bandwidth and long-distance coverage. Across the operating band, a microprocessor-controlled automatic tuning unit tunes the antenna's electrical length for minimum reflected power and maximum radiated power. Operators may use different length antennas for various operational roles.

Intended for special public safety and military applications, the unit is available in three frequency ranges: 30MHz to 43MHz, 43MHz to 61MHz and 60MHz to 88MHz.

Circle (480) on Fast Fact Card

Wideband Tx, Rx antenna covers 100kHz to 1.3GHz



A wideband transmit and receive antenna from **Ace Communications** spans 100kHz to 1.3GHz. The antenna has eight horizontal radials, eight diagonal radials and a vertical top whip element. Input power rating is 200W with 50Ω impedance. The antenna comes with N and BNC connectors and 50 feet of coax.

Circle (268) on Fast Fact Card

THE SS7 SUMMIT.

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Dinner Keynote Speaker
Craig McCaw, Chairman & CEO, McCaw Cellular

Circle (90) on Fast Fact Card

Meet These Dynamic Industry Leaders and Many More at the SS7 Summit.

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Harry Young, District Manager–Wireless Interconnection, Bellcore
Bruce E. Johnson, Staff Director–Signaling, Telesector Resources Group, a Nynex Company
William Blatt, Assistant Vice President, Technology Planning, Northern Telecom
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Raymond J. Bonelli, Manager, CCS7 Network Services & Support, AT&T Network Systems
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Karen Shinevar, Vice President, McCaw Cellular
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William T. Pruett, Director, Technology Strategy, BellSouth
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Rhonda Wickham, Editor, Cellular Business
James Butler, District Manager, CCS Product Management, Bellcore
William Adler, Executive Director–Federal Regulatory, Pacific Telesis
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Lonnie Smith, Product Manager, BellSouth
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Paul Hart, V.P., Technical Disciplines, USTA
John Wickens, President, PA Consulting
Steve Titch, News Editor, Telephony
Jack Harry, Director of Architectural and Strategic Planning, United Telecom

UHF portable antenna operates at 450MHz-512MHz

Model LAA 860 UHF low profile portable antenna is 4.5 inches long. The **Bendix/King** antenna operates from 450MHz to 512MHz.

Circle (356) on Fast Fact Card

Management software upgrades support SMR

The Communications Business Management Systems (CBMS) release 4.0 includes enhancements specially designed for the SMR industry. The **DBC Software** release includes repetitive billing, inventory, equipment tracking, receivables, payables, sales, service, payroll and general ledger.

Circle (326) on Fast Fact Card

Communications headset has noise-canceling earmuffs

The series IV radio communications headset from **Earmark** incorporates noise-canceling earmuffs built into the frame. Headset attributes include a 10% power reduction from previous models; hands-free operation; improved duplex operating range of about 8%; user-adjustable Vox; variable transmission power; intrinsic safety listing by UL; and durability. The headset comes in simplex, duplex, half-duplex and repeating models.

Circle (479) on Fast Fact Card

Equipment mounts enable 'no holes bored' installation

Installing mobile voice and data communications equipment in a vehicle without drilling holes in the floor is possible with **Gamber-Johnson's** "No Holes Bored" modular mount bases. The mounting bases are held in place by the vehicle's seat mounting bolts. Installation is quick, about 10 minutes or less. Models in the line are available for Ford Mustang, Tempo and Crown Vic; and Chevy Caprice, Camaro and Lumina Sedan. The company's DS series mount heads fit the bases.

Circle (327) on Fast Fact Card

Product line removes air contamination

The Fume-X-Tractor systems from **Pace** extract harmful elements from the air on the spot. The systems are designed for use at soldering areas.

Circle (337) on Fast Fact Card

Panel antenna suits 3-sector cellular systems

The PD 10197 90° sector antenna offers 11.5dBd gain for three-sector cellular systems. The **Celwave** antenna operates at 824MHz to 894MHz.

Circle (369) on Fast Fact Card

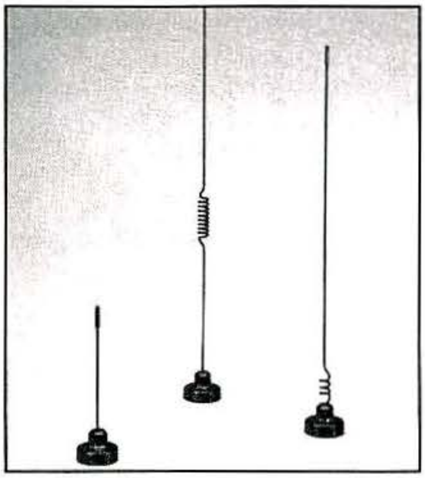
Circle (91) on Fast Fact Card

Circle (92) on Fast Fact Card

New products

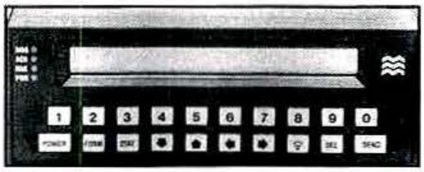
Rooftop antennas use improved mounting hardware

Rooftop antennas for trunking and cellular frequencies sport improved mounting hardware to provide better contact with a vehicle's metal surface. The **Mobile Mark** line of unity, 3dB and 5dB gain rooftops include the revisions.



Circle (354) on Fast Fact Card

Mobile data terminal offers 2-line by 40-column display



The STX-4000 mobile data terminal from **Millidyne** fits most radio modem or data-capable radios. The unit features a two-line by 40-column backlit display, easy-to-read keys and 10 status messages.

Circle (367) on Fast Fact Card

Plate for NEC phones fits pedestal mount

The 513 NEC plate for the 3800 and 4800 series phones eliminates the use of the clam shell that is normally included in the phone kit. The **SMC Electro-Mount** plate fits the company's standard pedestal mount.

Circle (332) on Fast Fact Card

Paging product facilitates page transmission, recording

The SF-65 digital and analog store and forward interfaces a remote receiver and a remote paging transmitter to record the digital or analog page directly off the air, key up the transmitter and retransmit the page. The **CTI** product provides transmitter keying functions such as PTT, audio, data and digital or analog select. The unit is capable of receiving and paging simultaneously with the proper linking arrangement.

Circle (347) on Fast Fact Card

Rack-mount dc converters accept 48Vdc input

Rack-mount dc converters from **Newmar** accept 48Vdc positive or negative input and produce 12V or 24V power at 400W. The units maintain output voltage to within 1% for all line and load conditions.

Circle (289) on Fast Fact Card

Software permits PCs to work with paging systems

The Notify software from **Ex Machina** permits personal computers to send messages directly to alphanumeric receivers without users needing to be present. Any software application running on those computers can send messages through local, regional and national wireless paging systems for display on personal alphanumeric receivers. Such information could include electronic mail, stock quotes, sports scores and scheduling.

Circle (371) on Fast Fact Card

ACSSB transceivers cover the 220MHz band

Model ESP500 ACSSB transceivers operate in the 220MHz-to-222MHz band. Three versions are available from **SEA** that feature field-programmability, CTCSS encode-decode, time-out timer and busy lockout programmable on a per-channel basis. Model ESP525DB is a four-channel version with an internal front-firing speaker and talk-around switch. Model ESP525DM is a 20-channel version with programmable scan. Model ESP525DH is a voice-data version with a built-in modem. All three versions are dash-mount radios.

Circle (473) on Fast Fact Card

UHF connector withstands climatic conditions

The RFU-503 weather-resistant UHF connector has a moisture seal between the cable and connector and one to the male-female interface. Made by **RF Connectors,** the connector features a nickel-plated body, silver-plated pin with a teflon dielectric and all-weather silicon rubber gaskets.

Circle (470) on Fast Fact Card

New products

Radio adapter offers PTT switch, volume control

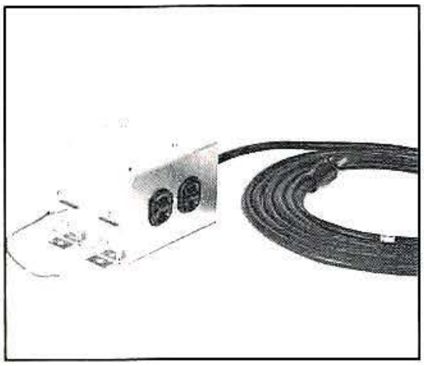
Model C3019 utility radio adapter and connector kit interfaces series 3000 noise-attenuating headsets and mobile radios. The **David Clark** adapter incorporates a PTT switch, volume control, belt clip and RFI shielded coil cord that extends to 15 feet.

Circle (285) on Fast Fact Card

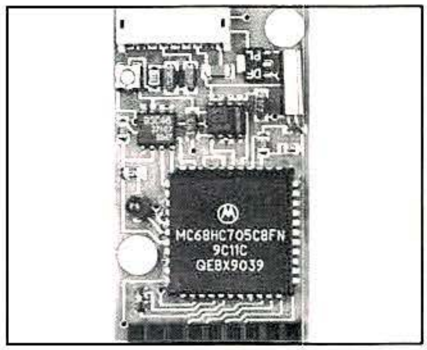
Power line protector works in two stages

Model IS-PLDO power line protector from **PolyPhaser** protects 120Vac lines to 15A. The protector functions in two stages, with the first stage turning on at ±200V. The second stage works when the inductive voltage drops plus the voltage across the first stage exceeds ±550V. The protector has EMI and RFI filtering and is EMP-rated.

Circle (309) on Fast Fact Card



Four-call paging encoder allows 10 million codes



Model PE-4 four-call paging encoder in POCSAG format allows more than 10 million different codes to be encoded. The **Communications Specialists** encoder fits a wide variety of radios and can be programmed to send calls containing tone only or with a numeric message with as many as 10 digits. Programming is contained in a non-volatile EEPROM.

Circle (312) on Fast Fact Card

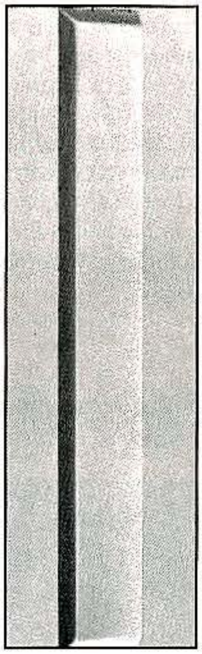
Standard enclosures make 48-hour delivery time

The standard 10-feet by 12-feet and the 12-feet by 20-feet steel-reinforced transportable equipment shelters from **Easi-Set** have a 48-hour delivery time anywhere in North America. The buildings include water-tight roof and floor and resistance to cracking.

Circle (336) on Fast Fact Card

Panel antennas satisfy 820MHz-to-960MHz uses

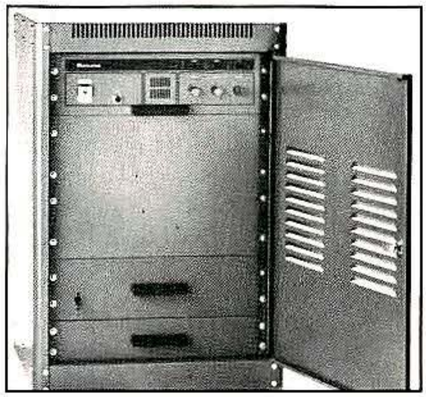
The DB878H 8-foot panel antennas provide 14dBd-to-15.2dBd gain for use in the 820MHz-to-960MHz range. The **Decibel Products** antennas include 7°, 120°, 105° or 83° horizontal beamwidths; 500W maximum input; and a 1.5:1 VSWR or better. The antennas have a gray fiberglass radome, brass radiating element and aluminum back panel.



Circle (350) on Fast Fact Card

Base, repeater stations permit adjustable RF output

Base-Tech base and repeater stations feature programmability for eight Tx and Rx frequencies; adjustable RF output of 90W to 140W or 180W to 250W; and protection against high VSWR. The **Midland LMR** continuous-duty models have full-duplex capability and are switch-selectable for dispatch or repeater operation. CTCSS and DCS are built in.



Circle (340) on Fast Fact Card

Circle (98) on Fast Fact Card

Circle (99) on Fast Fact Card

Visit us at IMCE, Booth #1121.

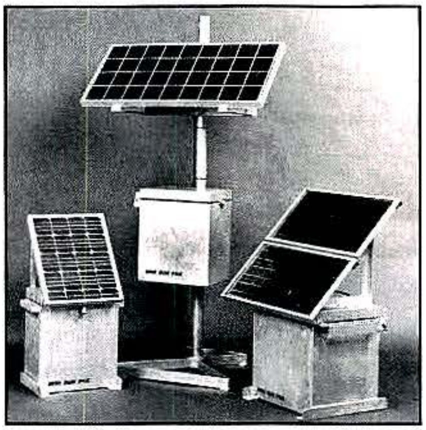
New products

GPS receiver module incorporates 5 channels

A five discrete-channel OEM GPS receiver module is available from **Magellan Systems.** The receiver offers shorter acquisition times, continuous one-second position updates and favorable tracking in high-dynamic situations and areas of obstructed satellite visibility. The five-channel code module accommodates vehicle tracking, military, vehicle navigation, marine and other uses.

Circle (259) on Fast Fact Card

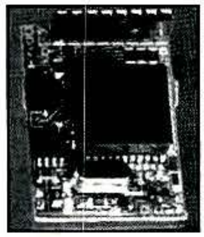
Solar electric generators come in 12Vdc, 24Vdc units



The Mini Sun Pak solar electric generators suit low- to moderate power requirements and come in 12Vdc and 24Vdc configurations. Outputs start at 5W. The **Photocomm** units include a 20-day sealed and maintenance-free battery as a reserve for operation in inclement weather.

Circle (302) on Fast Fact Card

Morse code station ID programs via keypad



The ID-1 miniature Morse code station identifier automatically transmits a 16-character station ID or a 130-character message or both at user-programmable intervals. The **Midian Electronics** station ID can be programmed via a 12-button keypad for front porch delay, code speed, Morse tone frequency, bypass for PTT queuing and automatic repeat intervals.

Circle (291) on Fast Fact Card

Wideband antennas exalt side-fed dipole design

Wideband sector cellular antennas from **Celwave** offer 16dBd gain and cover 806MHz-to-960MHz applications. The antennas have side-fed dipole designs and low loss stripline feed systems.

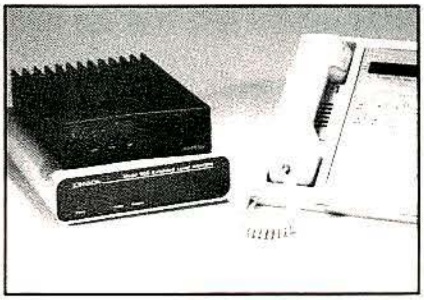
Circle (338) on Fast Fact Card

ESN reader handles logging, system surveying

The ESNR-5900A cellular ESN reader from **Curtis Electro Devices** allows logging and system survey functions. The logging function allows 180 sets of signal strength measurements in dBm for active forward control channels, system A or B. The survey function scans voice and data channels for 10 seconds.

Circle (330) on Fast Fact Card

Deskset, interface module fit trunked control stations



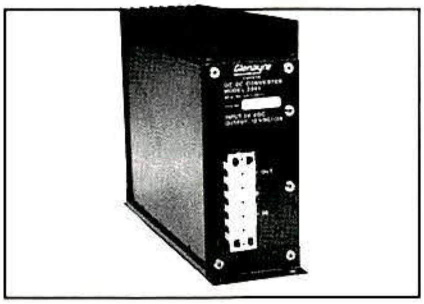
Model 940 deskset extends local control for trunked control stations and includes controls for operation of 8600 series trunked radios. Functions include intercom, privacy and supervisor features. **E. F. Johnson's** model 960 interface unit allows the use of 10 desksets as far as 2,000 feet from the interface module.

Circle (297) on Fast Fact Card

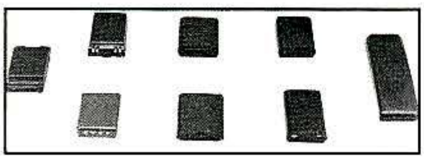
Dc-to-dc converters' output adjusts from 12Vdc to 14Vdc

The GL2860 series of dc-to-dc converters boast heavy-duty design and adjustable outputs in the range of 12Vdc to 14Vdc. The **Glenayre Electronics** converters provide efficient power conversion, good regulation and protection against misuse. Nominal inputs in the series include 24Vdc, 36Vdc, 48Vdc, 72Vdc and 130Vdc.

Circle (344) on Fast Fact Card



Rechargeable batteries fit cellular phones



Power Up QCC batteries are available for portable and transportable cellular telephones from **Ora Electronics.** The NiCd batteries fit models Audiovox CTX-5000/PT-300 portable; Ericsson Hotline Pocketphone portable; Fujitsu Pocket Commander portable; GE Pocketphone portable; Kenwood KMP-H700 portable; Mitsubishi 800 and DiamondTel 95T transportable; Mitsubishi 900 and DiamondTel 90X transportable; NEC P201/P301; Nokia PT612 portable; NovAtel PTR800 portable; Oki 710 and 900 portables; Panasonic EB362, EB3500, TP500 and HP600/EBH30; Technophone PC205A portable; and Uniden CP 5000 portable.

Circle (329) on Fast Fact Card

Report evaluates 220MHz narrowband

A market study that analyzes the 220MHz band established by the FCC for narrowband RF equipment is available from **Mobile Data Specialists.** The report predicts a market growth of more than $700 million in five years. Digital radio impact, 800MHz and 900MHz market growth, spectrum refarming, standards and suppliers are discussed. A niche market scenario is described for narrowband radios.

Circle (204) on Fast Fact Card

Catalog details replacement batteries

Replacement batteries for two-way hand-held radios, pagers, cordless phones and test equipment are listed in **Multiplier's** battery catalog. Custom battery packs for special applications and obsolete battery replacements are included. Cellular batteries and accessories are featured.

Circle (214) on Fast Fact Card

Guide describes coaxial cable fire retardance

"Fire-Retardant Coaxial Cables and Elliptical Waveguides for Indoor Applications" details electrical, building and fire code requirements for coaxial cables and elliptical waveguides. **Andrew's** guide explains requirements affecting cables and waveguides installed indoors.

Circle (212) on Fast Fact Card

Catalog describes lightning equipment

Dissipaters, ground grids and Helo ground systems are described in **Lightning Prevention Systems** equipment catalog. Grounding rods, wire and other grounding hardware also are listed. Dissipation technology and grounding techniques are discussed.

Circle (209) on Fast Fact Card

Catalog lists electronic components

Jensen's Master Catalog lists tools and instruments for inspection, assembly and field service of electronic components and equipment. Analyzers, monitors, meters, testers, probes, static control devices and soldering supplies are included in this 256-page publication.

Circle (211) on Fast Fact Card

Continued from page 32
simple and requires a variable-frequency audio source to modulate the RF carrier. Modulating the service monitor with the proper DCS code set to 500Hz FM deviation, adjust the amplitude of the audio oscillator to bring the total FM deviation up to the rated level, usually 5kHz.

Next, adjust the audio oscillator to 3,000Hz and measure the RF level required to open the DCS decoder reliably. Repeat this procedure, each time adjusting the audio oscillator frequency downward in 500Hz steps, measuring the DCS decoder's threshold sensitivity.

When the audio frequency source is at about 1,000Hz, make adjustments in smaller increments.

At some frequency close to 300Hz, the decoder will be completely blocked by the audio frequency signal. To obtain a *blocking curve*, graph the results with the audio frequency on the horizontal axis and the decoder threshold sensitivity on the vertical axis.

The blocking curve provides a method for judging how susceptible a DCS decoder is to voice blocking in actual usage. Certain users can intentionally voice-block DCS decoders by growling into the mic, but the effect should not occur frequently with normal voice communications. Voice-blocking is more likely to occur when the communicator is a man with a loud, bass voice. A DCS decoder should not be blocked by audio frequencies above 300Hz.

Some DCS receivers may exhibit a tendency to block when receiving an off-channel *signal.*

Make sure to run multiple blocking curves with the RF carrier frequency offset from the nominal operating frequency. The maximum offset should correspond to the maximum netting error. As before, do not automatically assume that the blocking curves will be identical at equal but opposite carrier offsets.

In addition, run the blocking curves at several different offsets because the blocking curve shape can change significantly. Some DCS receivers may exhibit a tendency to block when receiving an *off-channel* signal. Although a certain amount of degradation is expected, too much will affect radio performance adversely.

Field testing

Finally, after all the bench testing is complete, conduct some field testing to evaluate the radios' performance. Equip two radio transceivers with the selected DCS devices and make comprehensive unit-to-unit tests. Make sure to adjust the radios manually to anticipated worst-case conditions to see how well they perform.

Feedback

Construction costs 'on budget'

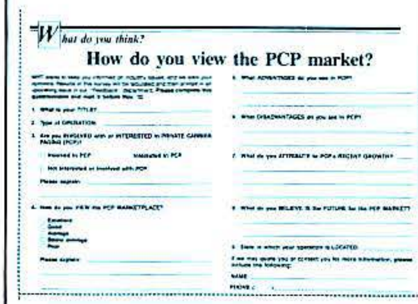
Most of the costs to build a communications systems are on budget, according to respondents to the July 1991 "What Do You Think?" questionnaire. Readers indicate that materials are the biggest single building cost, followed by engineering and consulting services. Statistics include:

SYSTEM CONSTRUCTION COSTS	%
Costs as budgeted	47.4%
Costs were over budget	28.9%
Costs were under budget	10.5%
No response	13.2%

Readers outline some of these costs:

- "A three site simulcast VHF system costs $140,000. This is a stop-gap to an 800MHz trunk system. Consulting has cost the politicians $80,000 so far."
- "The two-year battle to get tower use and height cost more than the system."
- "Because of the foreign exchange shortage and high duties (55%) and high bank interest rates of approximately 36%, materials tend to be the highest cost," according to an SMR operator in Jamaica.
- "Engineering, 10% overhead; materials, 60%; labor, 30%."
- "Labor costs can exceed materials on tower installations; we were fortunate to have good building and top locations."
- "Land, labor and materials were approximately divided."
- "Original equipment did not perform. Replacing it cost money."
- "System required a lot of different kinds of materials for building and testing, as well as test equipment."

Be sure to fill out this month's "What Do You Think?" questionnaire on page 129 so your responses can be included in a future "Feedback" columns.


What do you think?
How do you view the PCP market?

*P*eople

Bolen

Faust

Saul

Thorton

Gary Bolen leaves NovAtel Communications, Calgary, Alberta, as manager of narrowband products. He becomes director of sales and marketing for Tait Electronics, Houston.

Theodore R. Faust leaves Commonwealth Communications Industries, Ashland, VA, as vice president of sales and marketing to join EG&G Frequency Products, Cincinnati, as director of sales.

William V. Saul exits E. F. Johnson, Minneapolis, as product manager for mobile products to join SEA, Mountlake Terrace, WA, as product manager for land mobile products.

Tom Thorton leaves Western Towers, San Angelo, TX, as executive sales representative to join Falcon Tower Fabricators, San Angelo, TX, as vice president of marketing and sales.

Promotions and corporate restructuring at Transcrypt International, Lincoln, NE:

Alan Stewart advances from director of marketing to vice president of marketing.

Tom Tambling, former director of sales, moves up to vice president of sales.

Ron Kabler advances from director of engineering to vice president of engineering.

John Connor leaves Deloitte and Touche, Lincoln, NE, as senior partner to join Transcrypt as chairman.

Pat Bluthardt advances to president and chief operating officer.

John and **Vonnie Kuijvenhoven** remain on the board of directors.

Mark Golden leaves the Association of Telemessaging Services International (ATSI) as vice president of legislative and regulatory activities to join Telocator as vice president for government relations.

Wayne Stephenson, customer service manager at Relm Communications, Indianapolis, adds LMC systems and LMC components sales manager to his responsibilities.

Calendar

February

7-13—Cellular Telecommunications Industry Association 1992 Winter Meeting and Exposition, New Orleans. Contact: 202-785-0081.

18-20—International Mobile Communications Expo/Spring, Las Vegas Convention Center, Las Vegas. Contact: 303-220-0600.

March

29-April 1—Energy Telecommunications and Electrical Association '92, Dallas Convention Center, Dallas. Contact: 214-235-0655.

April

12-15—North Central Regional Conference Associated Public-Safety Communications Officers Meeting, Pheasant Run Resort and Convention Center, St. Charles, IL. Contact: T.G. Mieure, 708-244-8640.

May

7-9—1992 Annual Mobile Communications Conference, Westin ANA Hotel and Resort, Washington, DC. Contact: National Association of Business and Educational Radio, 800-759-0300.

11-13—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency, Denver. Contact: John Tary, 303-452-6111, ext. 443.

13-15—Radiocomm Annual Convention, Montreal. Contact: Lisa La Prairie, 613-233-4888.

17-20—East Coast Regional Conference Associated Public-Safety Communications Officers Meeting, Lancaster Host Resort, Lancaster, PA. Contact: James Giannini, 215-631-6500.

June

21-25—Utilities Telecommunications Council 44th Annual Meeting, Hyatt Civic Plaza, Phoenix. Contact: Rita Clark, 301-621-7802.

July

19-23—Forestry-Conservation Communications Association, Toledo, OH. Contact: Don Pfohl, 602-644-3166.

August

9-14—Associated Public-Safety Communications Officers 58th National Conference, Washington State Convention Center, Seattle. Contact: 800-824-1850.

September

1-3—International Mobile Communications Expo/Fall, Georgia World Congress Center, Atlanta. Contact: 303-220-0600.

21-25—Mobile Communications Marketplace, Moscone Center, San Francisco. Contact: Telocator, 800-326-8638.

October

8-10—Special Industrial Radio Service Association Annual Meeting, Grove Park Inn, Asheville, NC. Contact: Barbara J. Levermann, 703-528-5115.

24-29—International Association of Chiefs of Police 98th Annual Conference, Detroit and Windsor, Ontario. Contact: 703-243-6500.

November

20—Radio Club of America Annual Meeting and Awards Banquet, New York Athletic Club, New York. Contact: 201-246-7271.

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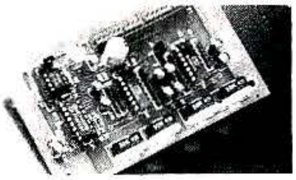

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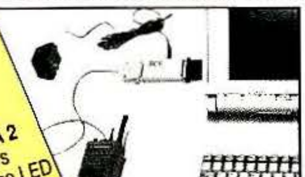

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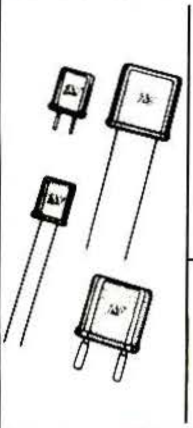

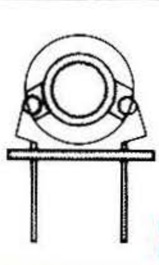

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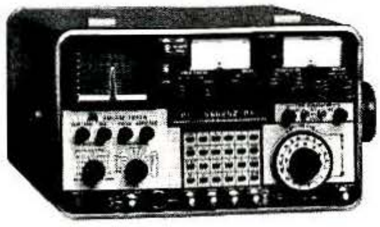

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Company	Page Number	Fast Fact Number	Advertiser Hotline
Advanced Computer Controls	72	114	408/727-3330
Advanced Electronic Filter	118	141	716-656-1105
Air Comm	112	123	602-275-4505
Alcom Electronics Inc.	125	154	800-476-2526
Antenex Inc., Signal Prop Sys	100	96	800-323-3757
The Antenna Farm	120	146	800-255-6222
The Antenna Specialists Co.	32	33	216-349-8400
Astron Corp.	53	45	714-458-7277
Automation & Electronic Engr. Inc.	114	129	800/527-4596
Avcom of Virginia	84	78	804-794-2500
A W Enterprises	108	110	800-334-4884
Barnett Engineering	22	29	800-268-2646
BEE Electronics Inc.	94	89	708-345-0337
Bendix/King	63	54	913-842-0402
Berry Controls Inc.	118	139	412-746-8888
Bomar	8,118	8,140	800-526-3935
Cadex Electronics Inc.	100	97	604-421-0061
California Radio	119		800-231-0103
Carlson Communications	16	14	800-283-6006
Cartwright Communications	61	52	513-489-1755
Celwave	24-25	20	800-321-4700
Centurion International Inc.	39,117	32,138	800-228-4563
CES Inc.	7	7	407-679-9440
Channel Element Headquarters	113	125	800-237-9654
Chargeguard Corp.	114	128	800-458-3410
Cimarron Technologies	15	13	800-487-7184
David Clark Company Inc.	37	30	508-756-6216
CML Technologies Inc.	55	47	800-258-0911
Coded Communications	32B, 32H	112,113	800-228-6367
Combined Technologies Inc.	105	106	513-595-5900
Communications Specialists	BC	3	800-854-0547
Communications Associates	47,113	39,124	800-435-9313
COMPUQUEST Inc.	116	132	800-722-2353
COMTELCO Industries Inc.	102	100	708-790-9894
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Control Signal Corp.	26	21	303-989-8000
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Curtis Electro Devices, Inc.	107		800-332-2790
Cushcraft/Signals Corp.	17	15	800-258-3860
Cybersym Control Sys	121	149	703-268-5400
Daniels Electronics	90	85	604-382-8268
Datacom	104	104	217-222-0160
Dataradio Corp.	106	107	404-392-0002
Data Signal Inc.	50	42	912-883-4703
DB Mobile	75	63	800-388-2112
Decibel Products, Inc.	59	50	214-631-0310
Dynatech Tactical Comms	88	83	603-880-4411
EMR Corp.	106	108	602-581-2875
Fanon Courier	114	127	800-345-1354
Freeman Engineering Assoc.	33	27	504-831-7785
Gamber Johnson	52	44	715-344-3482
General Communications	81,120	69,147	800-356-3200
GLB Electronics	74	66	716-675-6740
Doug Hall Electronics	86	81	614-261-8871
Harger Lightning Protection	96	91	708-362-4848
Hark Electronic Systems Inc.	85	79	800-FOR-HARK
Henry Radio	30	25	213-820-1234
Hewlett Packard	29	24	509-921-4001
Hustler Inc.	68,69	58,59	800-327-9076
Hutton Communications	98,99	94,95	214-239-0580
HY-Q International	119	144	606-283-5000
ICOM America	49	41	206-454-8155
IFR Systems, Inc.	67	57	316-522-4981
Industrial Comm Engineers	76	68	800-ICE-COMM
Industrial Electric & Elecs. Inc.	124	158	617-585-9100
International Crystal Mfg.	78	71	405-236-3741
Kenwood U.S.A. Corporation	Belly Band		213-639-4200
Kenwood U.S.A. Corporation	57	61	213-639-4200
Marden Electronics	116	134	414-763-6093
Marketronics Corp.	38	31	800-845-1230
Maxon America Inc.	71	49	816-891-6320
Maxrad, Inc.	31	26	708-595-3933
McManus Communications	117	136	501-763-6250
Mechem Electronics	116	133	703-373-3888
Micro-Quick Systems, Inc.	122	151	800-874-7749
Microwave Filter Company Inc.	87	82	315-437-3953
Midian Electronics Inc.	73	62	602-884-7981
Midland International LMR	IFC	1	800-MID-LAND
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Multiplier Industries Corp.	40	34	914-241-9510
MX-Com Inc.	9	9	919-744-5050
NEC America	13	11	214-907-4000
New Mar	18	116	714-751-0488
Norcomm Corp.	86	80	916-477-8400
Norton Engineering	123	153	703-938-5745
NS Electronics	126	157	408-432-8100
Omnicron Electronics	76	70	203-928-0377
Orbacom Systems Inc.	35	28	609-829-4455
Pekaar Communications Inc.	119	145	201-772-0704
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Polyphaser Corp.	93	88	800-325-7170
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Primus Electronics Corp.	108	111	800-435-1636
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Radio Express, Inc.	114	159	703-266-1928
Radiomate	111	121	800-346-6442
Radio Wholesale	111	120	800-53R-ADIO
Ramsey Electronics	96	92	716-924-4560
Ranger Communications	77	65	619-259-0287
RCW Distributing	117	135	800-726-9015
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Ritron Inc.	51	43	317-846-1201
Rocky Mountain Comms Inc.	123		303-526-5454
Santa Fe Distributing	70	60	913-492-8288
Schlumberger Technologies	27	22	800-225-5765
Securitron Company	101	98	408-263-6434
Selectone Corporation	82	75	510-887-1950
Setcom Corp.	62	53	415-965-8020
Shinwa Communications of Am	54	46	800-627-4722
Shure Brothers, Inc.	65	56	800-25S-HURE
Sigtone, Inc.	48	40	800-525-8663
Sinclair Radio Laboratories	41	35	800-288-2763
Skyline Antenna Mgmt.	124	155	203/673-0380
SMC Electro-Mount	84	77	800-527-1079
Softwright	122		303-329-6388
Solar Electric Specialties	78	72	707-459-9496
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TEAC America, Inc.	97	93	213-726-0303
Telex Communications, Inc.	56	48	612-887-5596
T.L.P. Technologies Inc.	111	122	516-288-8228
Transcrypt International Ltd.	5	6	402-483-2961
Tripp Lite	28	23	312-329-1777
Trylon Manufacturing Co. Ltd.	80	74	519-669-5421
TX RX Systems Inc.	64	55	716-549-4700
Unipage	23	19	800-367-2864
VCP International Inc.	102,103	101,102	800-527-9366
Vega, A Mark IV Company	1	4	818-442-0782
Vital Power Technology	101	99	902-835-5551
Vocom Products Corp.	42	36	800-USA-MADE
Wacom Products Inc.	14	12	817-848-4435
WAVETEK	43	37	800-245-6356
Brian R. White, Co. Inc.	104	105	707-462-9798
Yaesu USA	IBC		213-404-2700
Zetron Inc.	60,89	51,84	206-820-6363


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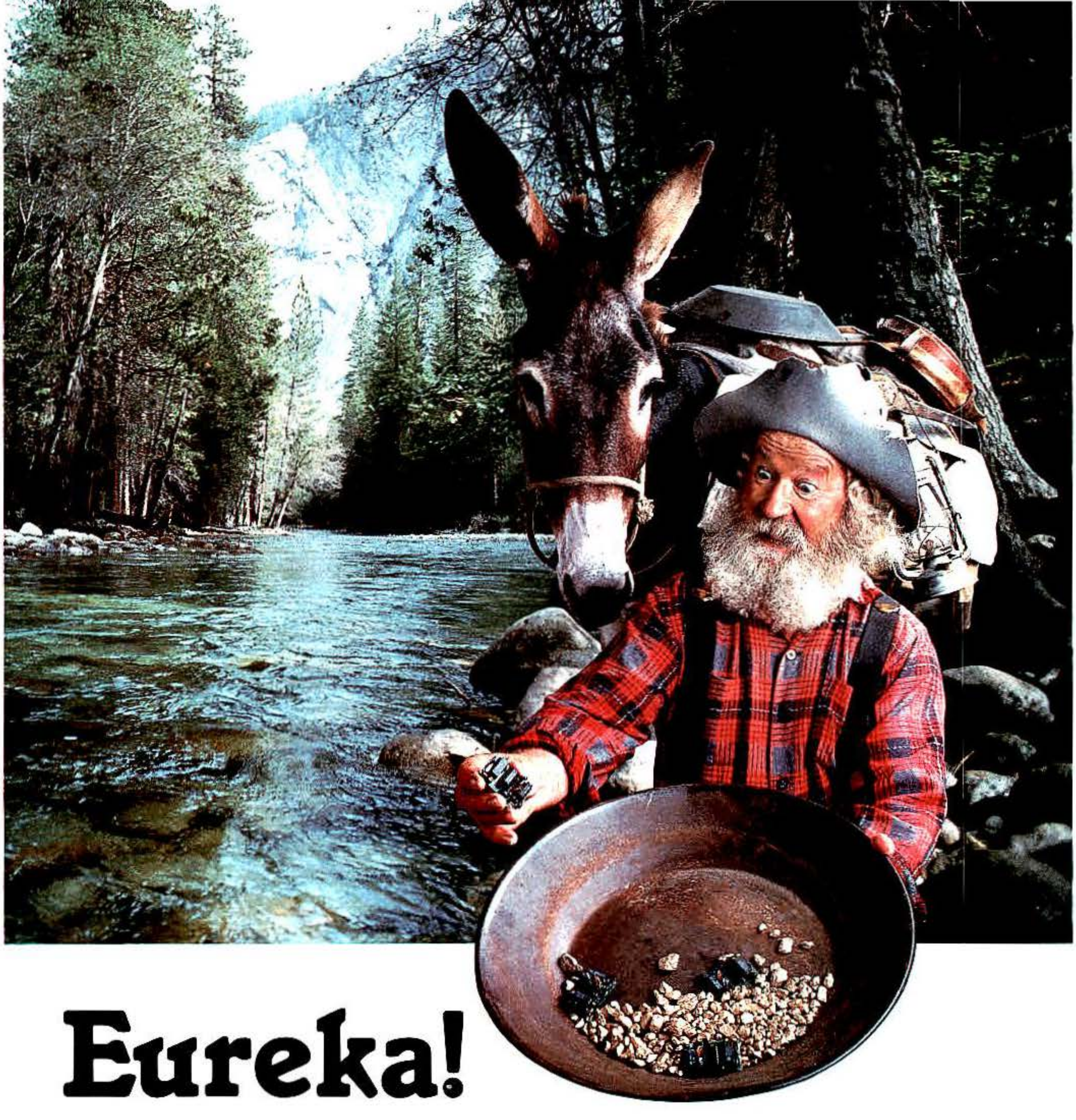

Eureka!